CAT/STA

United States
Department of
Agriculture

Forest Service

Alaska Region

R10-TP-51

December, 1994

Forest Health Management Report

Forest Insect and Disease Conditions in Alaska—1994

FOREST INSECT AND DISEASE CONDITIONS IN ALASKA -- 1994

General Technical Report R10-TP-51

January 1995

Prepared by:

Paul Hennon, Pathologist
Roy Mask, Entomologist
Ed Holsten, Entomologist

Forest Health Management
State and Private Forestry
Alaska Region
USDA Forest Service
3301 "C" Street, Suite 522
Anchorage, AK 99503

TABLE OF CONTENTS

List of Tables

List of Figures

FOREST INSECT AND DISEASE CONDITIONS IN ALASKA - 1994

CONDITIONS IN BRIEF

Although 1994 Alaska forest insect and disease damage levels remained static relative to 1993 levels, this year was characterized by some rather dramatic declines in some insect populations offset by equally dramatic increases in others. Spruce beetle, the most important agent of change affecting Alaskan spruce ecosystems, declined slightly by 80,000 acres in 1994. The most significant areas of decline were in the Haines area of southeast Alaska, and the Upper Copper River Valley, the Nulato River area, and parts of the Kuskokwim River, in interior Alaska. Other areas of the state, however, experienced notable increases in spruce beetle activity such as the east end of Lake Iliamna and the mid-Copper River Valley from Chitina south to Spirit Mountain and what appears to be one of the most rapidly expanding populations, from the headwaters of the North Fork of the Kuskokwim River near Lake Minchumina. Spruce beetle populations have remained static in the Kachemak Bay area where approximately 11,500 acres of on-going Sitka spruce mortality were noted along the south side of Kachemak Bay. Engraver beetle infestations increased sharply in 1994, primarily in the Yukon Flats region and in several river drainages nearby such as the Porcupine and Chandalar but most notably in the Christian River drainage.

Hardwood defoliator populations significantly declined from 113,000 acres of defoliation mapped in 1993 to 24,221 acres noted this year. The majority of this decline was due to the crash of large aspen tortrix populations in the Yukon flats area and the continued decline of the willow leaf miner complex in the same general area. Spruce forests throughout the state showed an increase in defoliation levels (446,119 acres). While southeast Alaska reported a decline of nearly 65,000 acres of black-headed budworm defoliation, interior Alaska white spruce forests showed an increase of nearly 200,000 acres of defoliation by the spruce budworm. The most significant increase in budworm defoliation occurred in the Tanana area where 150,000 acres were affected. Other areas of notable activity include the Nenana Ridge/Goldstream Valley near Fairbanks and near Big Delta where 21,964 acres of defoliated spruce were observed.

In southeast Alaska, the black-headed budworm outbreak impacted vast areas for the fourth consecutive year. Over 193,000 acres of black-headed budworm defoliation was noted in 1994, down approximately 65,000 acres from observations in 1993. Budworm activity was again concentrated primarily north of Frederick Sound. Budworm defoliation has been most common in high productivity, old-growth stands, at elevations less than 1000 feet. Substantial budworm defoliation is expected again in 1995. Hemlock sawfly populations in southeast Alaska declined significantly in 1994. Sawfly activity totalled approximately 3,400 acres (concentrated primarily in southern southeast Alaska), down from approximately 19,000 acres in 1993. Areas of concurrent budworm and sawfly defoliation comprised approximately 5400 acres, down from about 12,000 acres of such activity in 1993. Top-kill and some tree mortality was evident among western hemlock in several heavily defoliated areas. After a population crash in 1993, spruce needle aphid activity increased in several locales, including the immediate Sitka area. Aphids continue to weaken spruce that were severely defoliated in the previous outbreak (1992).

The total acreage of spruce beetle activity in southeast Alaska declined dramatically in 1994, however, two new areas of activity were identified. Spruce beetle activity in lower Glacier Bay National Park now totals less than 500 acres. Ongoing spruce beetle activity near Haines impacted an estimated

3,600 acres, down significantly from the approximate 20,000 acres observed in 1993. New spruce beetle outbreaks were noted on the north side of the Taku River opposite the mouth of the Wright River and in the Yakutat Foreland area south of Russell Fiord. On the Taku River, all of the stands with spruce beetle activity had also experienced light to moderate black-headed budworm defoliation. During the summer of 1994, activity by *Ips* engravers was especially evident in young, dense stands of Sitka spruce in and around the community of Haines.

Based on both ecological and economic considerations, yellow-cedar decline, wood decay of live trees, and hemlock dwarf mistletoe were the most important diseases of Alaskan forests during 1994. All three altered ecological conditions including forest structure, composition, and succession. Heartrot and buttrot fungi caused significant cull in all tree species in Alaska, particularly in coastal forests where approximately 1/3 of the gross volume of forests is defective. Decay in living hardwoods throughout the state is considerable. Wildlife habitat is produced directly by heart rot and dwarf mistletoe through the formation of tree cavities and witches brooms, respectively. Hemlock dwarf mistletoe continued to cause growth loss, top-kill, and mortality in old-growth forests of southeast Alaska; its impact in young-growth stands depends on the presence of large infected residuals left after harvesting of the previous stands. More than 550,000 acres of yellow-cedar decline has been mapped throughout an extensive area of southeast Alaska. Snags of yellow-cedar accumulate on sites of decline and forest composition is substantialy altered as yellow-cedar trees die giving way to other tree species.

Foliar diseases of conifers are usually of little ecological significance and were generally at moderate levels throughout Alaska in 1994. The fungus *Rhizosphaera pini*, however, was found at high levels for the second consecutive year in southeast Alaska. A needle disease of second-year needles on Sitka spruce caused by the fungus *Chrysomyxa weirii* is typically uncommon, but occurred at the the most damaging levels ever recorded in southeast Alaska during 1994. Hemlock canker disease subsided in 1994. This disease had killed western hemlocks along roads of Prince of Wales, Kuiu, and Chichagof Islands during the four previous years. Canker and foliar fungi caused a large, but unmeasured damage to hardwood species in interior Alaska.

Porcupines continued to damage Sitka spruce and western hemlock in valuable young-growth stands and brown bears wounded the lower boles of yellow-cedars in southeast Alaska.

Table 1 summarizes insect and disease activity by land ownership.

Table 1. 1994 Forest insect and disease infestation in Alaska by land ownership and agent.[1]

Pest Agent	National Forest	Other Federal	Native	State & Private
	Acres			
Spruce beetle	12,790	191,040	60,150	375,940
Engravers	----	13,580	5,300	2,840
Spruce budworm	----	11,400	62,920	158,630
Black-headed budworm	156,710	3,110	7,240	27,170
Hemlock sawfly	3,170	----	250	----
B.-h. budworm & h. sawfly	2,050	----	----	3,350
Spruce needle aphid	150	----	----	1,810
Large aspen tortrix	----	----	----	9,840
Alder defoliation	----	50	----	450
Cottonwood defoliation	470	100	2,270	380
Willow defoliation	470	3,630	3,330	1,580
Larch Sawfly	-----	----	----	310
Black Moth	----	360	----	1,040
Blowdown	2,870	----	----	390
Flood damage (spruce)	----	----	----	620
Flood damage (birch)	----	----	----	250
Yellow-cedar decline[2]	550,380	----	17,670	10,430
Totals =	729,060	223,270	159,130	595,030

Grand Total = 1,706,490 acres

1 Table entries do not include many of the most destructive diseases (e.g., wood decays and dwarf mistletoe) because these losses are not detectable in aerial surveys.

2 Value of yellow-cedar decline is not restricted to the acreage with a high concentration of dying trees for this year; it represents stands that generally have long-dead trees, recently-dead trees, dying trees, and some healthy trees. See discussion of yellow-cedar decline for a detailed listing of acreage affected by island and Ranger District.

STATUS OF INSECTS

ROLE OF DISTURBANCE IN ECOSYSTEM MANAGEMENT

A key premise of ecosystem management (based on natural variability) is that native species have adapted to, and in part, evolved with natural disturbance events. Species loss and ecosystem change have been observed in areas where "natural" disturbance regimes have been substantially altered. Disturbances, large and small, are responsible for the way current landscapes appear and function today. Disturbances of various kinds and intensities will determine the structure, composition, and function of future landscapes. Alaska ecosystems are shaped/produced by disturbances. Just note the effects of glaciation, earthquakes, tidal waves, fire, flooding, etc. Alaska forest ecosystems, especially those of interior Alaska, are characterized by change. Disturbance events such as fire, insect and disease outbreaks create and maintain a shifting mosaic of landscape patterns. Both fire and flooding are responsible for spruce and birch regeneration in south-central and interior Alaska; large scale windthrow is important in southeast Alaska. Fire burns across the landscape in an irregular and uneven manner. The burned surface may or may not be essentially the same as the pre-burned surface. Succession after fire in Alaskan forest ecosystems is complex and related to site, fire, climate, type and age of the vegetation present before fire and plant species available for sprouting or invasion after fire. Alaska insect communities, probably one of the largest components of forest ecosystems, are also "creatures" of disturbance as well as agents of disturbance.

Arctic/boreal insect populations are characterized by low number of species and large population numbers. Such species are opportunistic in their behaviors. They respond quickly to disturbances in climate, food, and breeding material. The spruce bark beetle for example, responds quickly to large scale blowdown, fire scorched trees, or spruce impacted by flooding. Large beetle populations can be produced by such breeding material leading to potential outbreaks.

As agents of disturbance, spruce beetles are one of the most important mortality agents of mature spruce stands in Alaska. There are a variety of impacts associated with outbreaks to forest resources, both timber and non-timber. These impacts can be viewed positively or negatively depending on the forest resources in question. Some of the impacts associated with spruce beetle infestations include, but are not limited to:

(1) Loss of merchantable value of killed trees: The value of a spruce as sawtimber is reduced within three years of attack in south-central Alaska as weather checking and increased sap-rots occur. The value of a beetle killed tree as houselogs, chips, or firewood continues for some time; **(2) Long term stand conversion:** To optimally regenerate both spruce and birch, a site disturbance (i.e. fire, windthrow, flooding, etc.) is required which results in a seed bed comprised of bare mineral soil with some organic material. If there is adequate seed source, such site disturbances provide excellent sites for regeneration. However, what is occurring on many sites in south-central Alaska after spruce beetles have "opened up" the canopy is that there is a paucity of regeneration establishing as there has been minimal site disturbance. Under such conditions, grass and other competing

vegetation quickly invade the site and prevent future colonization by tree species; **(3) Impacts to wildlife habitat:** Those wildlife species that are dependent on large diameter spruce stands are negatively impacted. Those species that benefit from early successional stage vegetation will benefit from spruce beetle infestations as stand composition changes; **(4) Impact to scenic quality:** Recent studies have demonstrated that there is a significant decline in scenic quality of spruce beetle impacted stands and that scenic beauty is an important forest resource. Along scenic corridors such as National Scenic Byways, maintaining or enhancing scenic quality necessitates minimizing impacts from spruce beetle infestations; **(5) Fire hazard:** There is concern that fire hazard of spruce beetle impacted stands will increase over time as dead trees fall, dry grass accumulates, thus increasing fuel loading; and **(6) Impact to fisheries:** If salmon spawning streams are bordered by large diameter spruce and if these trees are subsequently killed by spruce beetles, there is a concern as to the long term availability of large woody debris in the streams. A continual supply of large woody debris in spawning streams is a necessary component for spawning habitat integrity.

There are a variety of techniques that can be used to prevent, mitigate, or reduce impacts associated with spruce beetle infestations. However, before pest management prescriptions can be developed, the resource objective(s) for a particular stand, watershed, landscape, etc. must be determined. The forest manager must evaluate the resource values and economics of management actions for each stand in light of management objectives. The beetle population level must also be considered because population levels will determine the priority of management actions and the type of strategy to be invoked. Properly applied silvicultural practices as well as fire management in south-central and interior Alaska, can maintain the forest diversity needed to provide the range of products and amenities available in the natural forest.

SPRUCE BEETLE
Dendroctonus rufipennis Kirby

Spruce beetles continue to impact vast areas in Alaska (Fig. 1). Spruce beetle activity decreased slightly in 1994 by nearly 80,000 acres; 641,026 acres of newly infested and on-going infestations were detected aerially. Although most areas are in slight to moderate decline, other infestations have collapsed. For example, the 11,365 acre outbreak detected in 1992 along the Nulato River was only 55 acres this year; the 21,000 acres of infested spruce in the Haines area in 1993 declined to 3,625 acres in 1994. These decreases are offset somewhat by areas of significant increase, most notably: Kakhonak Lake to Pile Bay along the eastern end of Lake Iliamna which increased from 24,063 acres in 1993 to 46,946 acres in 1994; the North Fork of the Kuskokwim River from its headwaters near Lake Minchumina to Medfra contained 52,111 acres of infested spruce; Klutina Lake/St. Anne Lake area declined from 33,706 acres in 1993 to 37,754 in 1994 with many areas having 100% mortality. The two major spruce beetle outbreaks in southeast Alaska declined substantially. In the Haines area, only 3,625 acres were mapped in 1994 vs. 21,000 acres in 1993. The 2,800 acres of spruce beetle activity in Glacier Bay National Park reported in 1993 declined this year to 467 acres.

Areas of specific interest include:

Spruce mortality on the Chugach National Forest decreased by half in 1994; only 12,715 acres of ongoing infestations were noted. The areas of major activity on the Forest are from Ingram Creek to Hope and Palmer Creek--1,946 acres; and the Moose Pass area including Trail and Grant Lakes and the Placer River--3,036 acres.

From Pt. Possession at the northern tip of the Kenai Peninsula to Kachemak Bay in the south, spruce beetle caused mortality has decreased by almost 100,000 acres. The 1994 total is 283,994 acres (397,771 acres in 1993). From Skilak Lake south to Ninilchik and Homer and east to Caribou Hills, almost 54,179 acres of mortality was noted. East of the Caribou Hills, in the Fox River drainage, approximately 39,000 acres (an increase of 9,000 acres) of spruce beetle activity was aerially detected in 1993.

In the Kachemak Bay area, acres impacted by spruce beetles have increased slightly this year, 51,000 acres of infested spruce were aerially detected. The most intense areas of activity are along the north side of the bay and in the Fox River Valley where 39,077 acres of infested spruce were observed. Much of the affected acreage is located on lands in private ownership along East End Road. On the south shore of the bay, spruce beetle activity is as follows: Humpy Creek to Bradley Lake--8,874 acres; Halibut Cove--2,024 acres; China Poot Lake--467 acres; Sadie Cove--78 acres. No activity was noted in the Seldovia area. Even though there was a slight decrease in infested areas as determined by aerial surveys, ground checks indicated heavy 1994 beetle flights and attack levels in many areas near Bradley Lake. These recently infested areas will not become apparent until next summer.

On the west side of Cook Inlet, from Beluga Lake to Skwentna River, spruce beetle activity significantly decreased in 1994; only 120 acres of on-going infestations were observed this year vs. more than 1,500 acres last year. The most significant area of spruce beetle activity is located north of the Skwentna River, about 6 miles northwest of Porcupine Butte, and covers 2,491 acres between Finger Lake and Shirley Lake; a decrease of 50% over levels noted last year. The infestation detected in 1992 along the McArthur River remains unchanged; 1,868 acres were observed infested this year.

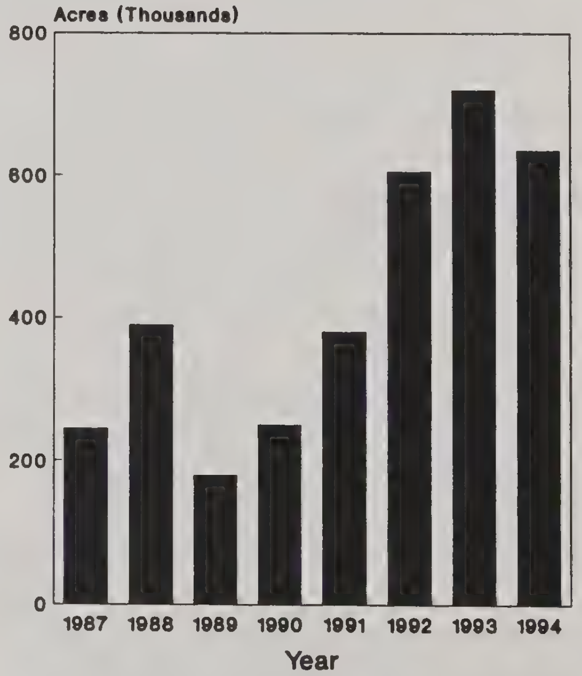

Figure 1. Acres of ongoing and new spruce beetle infestations in Alaska, 1987-1994.

Spruce beetle activity increased slightly in 1994 in stands of Sitka spruce along Turnagain Arm; 155 acres in 1993 vs. 1,320 acres in 1994. Activity increased along the Hope Road and Sixmile Creek to 590 acres with about 300 of those acres located at the mouth of Walker Creek. Along Resurrection Creek Road and Palmer Creek Road, mortality attributed to spruce beetles amounted to 730 acres.

Spruce beetle activity increased in the Anchorage Bowl area. The outbreak in south Anchorage increased with 1,946 acres of infested spruce reported this year. Fire Island spruce beetle activity rose sharply from 925 acres in 1993 to 1,868 acres in 1994.

Just north of Anchorage, the spruce beetle appears to be declining; 856 acres of infested spruce in the lower Eagle River Valley were reported while an additional 120 acres were detected at the head of the valley. This compares to 1,435 acres reported in 1993. In the Eklutna River Valley, 1,012 acres of spruce beetle activity are continuing. Activity in the Knik River/Palmer/Bodenburg Butte area declined by 50% to 2,335 acres. The most intense area of activity in the Matanuska Valley continues along the Glenn Highway from Chickaloon to Gunsight Mountain where 20,083 acres of infested spruce were detected in 1994. This represents an increase of 4,203 acres over levels noted in 1993. This is the third consecutive year of increase in this area. The beetle infestation appears to be moving east into scattered stands of spruce between Gunsight Mountain and Lake Louise and Tazlina Glacier. It is also moving from Klutina Lake towards St. Annes Lake.

Southwest of Anchorage, in the Iliamna-Lake Clark area, spruce beetle activity is on the increase. Throughout the east end of Lake Iliamna, from Kakhonak Lake to Pile Bay, spruce beetle caused mortality was detected over 46,946 acres; an increase of 22,883 acres over 1993 levels. In the Lake Clark area, from the northeast end of the lake to the pass, an ongoing infestation has subsided; only 547 acres of infested spruce were detected this year vs. 3,600 acres in 1993.

Many areas in the Copper River Basin continue to have aggressive spruce beetle populations (Fig. **8**). Areas of increasing activity include: Klutina Lake--37,754 acres; from Chitina south along the Copper River to Spirit Mountain--26,155 acres. From Gulkana in the north to Chitina in the south, and east to McCarthy, acres infested by spruce beetles have decreased somewhat from 170,045 to 135,012 acres; a decrease of 35,033 acres. The infestation along the Chitina River from the mouth of Tebay River east to McCarthy decreased from 19,694 acres in 1993 to only 3,737 acres in 1994. Areas of continuing activity include: 80,000 + acres from Copper River to the Tiekel River, west of the Copper River; 20,000 + acres along the east side of the Copper River from Copper Center to Chitina within the Wrangell-St. Elias National Park, and 4,814 acres in the Glennallen/Gulkana area which represents a decrease of 27,057 acres over 1993 levels.

Spruce beetle activity decreased for the third consecutive year along the Yukon River; 8,105 acres remain infested in 1994 vs. more than 100,000 acres five years ago. The Nulato River area, where 11,365 acres of spruce beetle activity were detected in 1992, significantly declined in 1994 as only 55 acres of scattered spruce mortality were observed.

The middle and lower portions of the Kuskokwim River Drainage experienced an overall decline in spruce beetle activity. The infested areas from McGrath downriver to Deacon's Landing decreased from 4,500 acres in 1992 to 362 acres in 1994. Upriver, however, areas of infested spruce from the North Fork of the Kuskokwim River near Lake Minchumina to Medfra have expanded to 52,111 acres.

During 1994 in southeast Alaska, the total acreage impacted by ongoing spruce beetle outbreaks declined, yet two new areas of activity were identified. Spruce beetle outbreaks near Haines and Glacier Bay National Park declined. Both outbreaks combined impact approximately 4,170 acres vs. 24,000 acres in 1993.

Spruce beetle activity in 1994 in lower Glacier Bay totalled approximately 470 acres. During the past decade and a half in this area, approximately 30,000 acres have been impacted by spruce beetle outbreaks. Many stands in the Beardsley Islands experienced spruce mortality as high as 75 percent during spruce beetle outbreaks in the 1980's. Wood rotting fungi, such as *Fomitopsis pinicola*, have rapidly colonized beetle-killed trees, causing many bole failures and resulting in numerous "new" forest canopy gaps (Fig. 6). Secondary plant succession follows in these gaps, among the many jackstrawed tree boles and tops. Observations to date on Lester Island indicate a predominance of hemlock regeneration in these disturbed/altered stands.

The spruce beetle outbreak northwest of Haines continued for a fifth consecutive year, although acres of active infestation (≈ 3,600) were down significantly vs. 1993 (≈ 20,000 acres). Salvage efforts continue on portions of beetle-impacted State land. In the absence of management intervention, recent windthrow events in the area will likely contribute to future spruce beetle outbreaks. Recent surveys in nearby areas of Canada have identified a substantial spruce beetle outbreak affecting over 20,000 hectares (≈ 50,000 acres) in the last 2-3 years.

New spruce beetle activity was identified on National Forest and private land along the Taku River, across from the confluence of the Wright River. Beetle activity there follows a large windthrow event that occurred in the fall of 1990. Spruce beetle activity of similar magnitude was also identified on the Yakutat Ranger District, in the Yakutat Forelands area near Russell Fiord. Scattered spruce beetle activity was observed in the Sawmill Creek Campground area (east of Sitka, AK) among large diameter spruce that had been repeatedly defoliated by spruce needle aphid, *Elatobium abietinum.*

In 1994, spruce beetle infestations throughout Alaska by ownership are as follows; National Forest land --12,790 acres; State and Private--375,940 acres, Native land--60,150 acres and other Federal lands (e.g. Kenai National Wildlife Refuge, National Parks, etc.)--191,040 acres.

ENGRAVERS
Ips perturbatus Eichh.

Engraver activity rose sharply in 1994 due primarily to the expanding infestation in the Yukon Flats area. The most intense areas of activity are along the Yukon River from Ft. Yukon upriver to Circle City where 7,084 acres have been infested and along the length of the Christian River where 6,851 acres of scattered infestation were noted. The only

area of significant engraver activity outside of the Yukon River and its tributaries is a 2,102 acre outbreak along Nenana Ridge just southwest of Fairbanks.

In southeast Alaska, nearly approximately 200 acres of *Ips* infested trees were observed in the Haines area. Several dense, immature stands of Sitka spruce in Haines and southward along the Chilkat Peninsula were infested by engravers. Many property owners implemented prevention, control and salvage measures.

SPRUCE BUDWORM
Choristoneura sp.

Areas of white spruce defoliation attributed to the spruce budworm (*C. fumiferana* & *C. orae*) rose from approximately 33,000 acres in 1993 to 232,477 acres in 1994. The largest area of activity (150,000 acres) is along the Tanana River and the confluence of the Tanana River and the Yukon River extending approximately 35 miles upriver and 42 miles downriver from Tanana. The infestation reported in the Nenana Ridge/Goldstream Valley area north and west of Fairbanks in 1993 has expanded by nearly 5,000 acres in 1994 to 27,634 acres (Fig. **8**). Other areas of significant activity include a 14,323 acre infestation along the Yukon River west of Ft. Hamlin extending for approximately 14 miles along the river; nearly 10,000 acres of defoliated spruce were detected along the Tanana River. Approximately 6 miles southwest of Tolovana, a 21,964 acre infestation along the Delta River from Big Delta to Harding Lake and another 5,060 acres of defoliated spruce approximately 25 miles upriver from Ruby along the Yukon River were observed. Spruce budworm outbreaks have been occurring for more than three consecutive years in many areas of interior Alaska. Research studies have shown that defoliated trees have been significantly stressed and there is concern that expanding engraver beetle populations in the defoliated area may take advantage of these weakened hosts and explode to outbreak proportions.

In southeast Alaska, spruce budworms defoliated approximately 470 acres of mature Sitka spruce and western hemlock along the Chilkat River north of Klukwan. This is in contrast to the 3,400 acres of defoliated spruce noted in the same general area last year.

WESTERN BLACK-HEADED BUDWORM
Acleris gloverana Walsingham

The black-headed budworm is native to the forests of coastal and southwestern Alaska. It occurs primarily in southeast Alaska and has been documented there since the early 1900's. Budworm populations in Alaska have been cyclic, arising quickly, impacting vast areas, then subsiding within a few years (Fig. 2).

In southeast Alaska, western hemlock is the budworm's preferred host, but Sitka spruce and mountain hemlock are also fed upon. The overall ecological role of the black-headed budworm in Alaska's forests is not known. However, many aspects of the budworm's role are known and several inferences can be made from available information.

Repeated years of budworm defoliation may cause growth loss, top-kill and in severe cases, death of the host. Heavily defoliated trees may also be more susceptible to other mortality agents. As a major forest

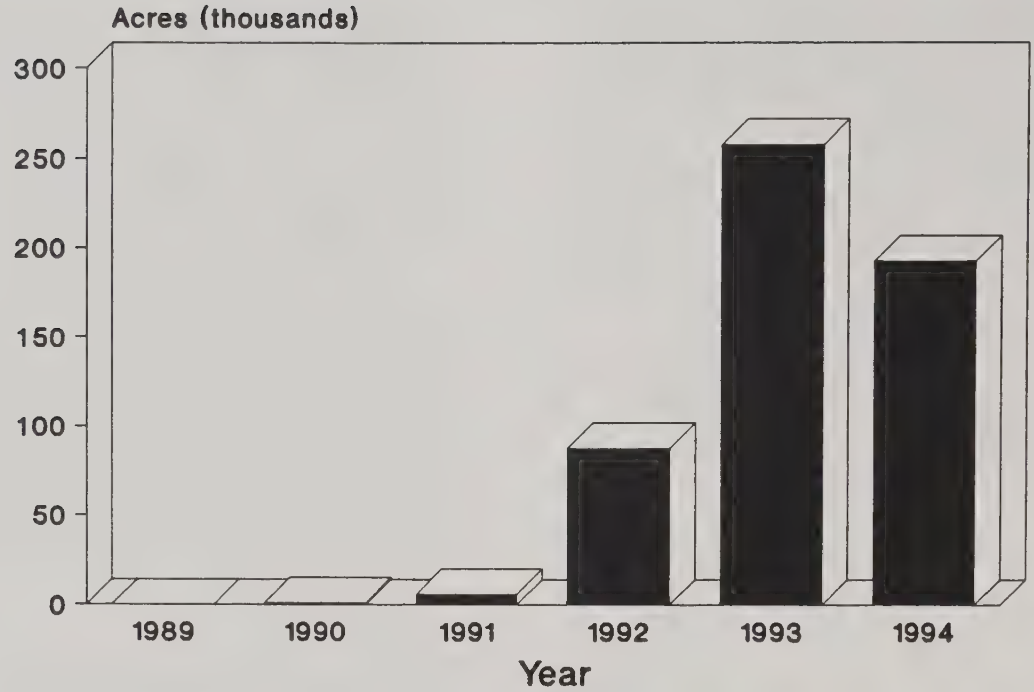

Figure 2. Acres of black-headed budworm defoliation in southeast Alaska, 1989-1994.

defoliator, black-headed budworm ultimately influences both stand composition and structure in some areas. To the extent that defoliation reduces overstory crown density (through tree death or crown thinning), less shade tolerant understory plants may become established. Such habitats favor small mammals, deer, predaceous and parasitic insects, and some insectivorous bird species. By consuming needles and depositing nutrient-rich fecal material on the forest floor, budworm larvae are also accelerating nutrient cycling processes. Recent investigations by the Pacific Northwest Research Station indicate that terrestrial insect larvae, such as budworm, may be a larger portion of the diet for some species of salmon fry, than was previously understood.

As of 1994, a small amount of black-headed budworm activity (948 acres) continues in Prince William Sound. 623 of these acres were detected between Tatitlek and Cordova in the Port Fidalgo, Port Gravina and Sheep Bay areas. This amount of defoliation represents a continuing decline of budworm populations in the Sound. The Turnagain Arm infestation which rose to 3,600 acres in 1992 and which declined in 1993 is apparently over as no defoliation was detected in 1994 aerial detection surveys.

1994 marked the fourth consecutive year of substantial black-headed budworm defoliation among the coastal spruce-hemlock forests of southeast Alaska. The last budworm outbreak of this magnitude in southeast Alaska occurred from the late 1940's to the mid-1950's. Over 193,000 acres of budworm-caused defoliation was mapped in July and August of 1993, down from approximately 258,000 noted during

the same period in 1993. Cool, wet weather retarded budworm larval development in the early summer months of 1994. Larval development was two-to-three weeks behind that noted in 1993. This may have contributed to some mortality and an overall reduction in budworm numbers (from defoliator plot data) and resulting defoliation.

Similar to 1992 and 1993, black-headed budworm activity in 1994 was concentrated in areas north of Frederick Sound. However, notable exceptions (to the south) include portions of Kupreanof and Mitkof Islands.

As in 1993, budworm defoliation was again most severe where it occurred in conjunction with that of the hemlock sawfly, on approximately 5,400 acres. The two insects in combination caused heavy defoliation of western hemlock along the Chilkoot River and adjacent to Chilkoot Lake near Haines (3,300 acres); adjacent to Crab Bay on Chichagof Island (600 acres); and on Mitkof Island west of Crystal Lake (1,400 acres). Top-kill and scattered mortality of western hemlock was observed in these three areas. Top-kill of western hemlock was also evident adjacent to Calder Bay, on northwest Prince of Wales Island (approximately 200 acres), an area defoliated by budworm and sawfly in 1993.

Since the budworm outbreak's inception in 1991, the greatest concentration of defoliation has occurred annually on Admiralty Island. Defoliation there in 1994 totalled approximately 92,000 acres, down from approximately 133,000 acres in 1993. In 1994, light defoliation (of western hemlock) was noted on Mansfield Peninsula on the slopes of Lone, Green, and Snowy Mountains. Light defoliation was also observed adjacent to Young Bay, in the Angoon/Mitchell Bay area, north of Chaik Bay, north of Whitewater Bay, , south of Wilson Cove, adjacent to Pybus Bay, encompassing most of Mole and Windfall Harbors, and at numerous locations on Glass Peninsula. Heavy defoliation, often associated with top-kill of western hemlock occurred above Florence Lake, in a band from the Fishery Creek drainage southeast to Thayer Lake, adjacent to Hood Bay, encompassing Gambier Bay, and at numerous locations on Glass Peninsula. The amount of tree mortality was not assessed from the ground, but the areas where hemlock top-kill was observed total approximately 28,600 acres.

Substantial budworm defoliation was again evident on Chichagof and northern Baranof Islands in 1994. On Chichagof, approximately 600 acres of light defoliation occurred in the Spasski Creek drainage, southeast of Hoonah. Light budworm defoliation elsewhere on Chichagof included: approximately 1,550 acres south of Neka Bay, 930 acres on the north side of Freshwater Bay, approximately 400 acres in scattered locations between Pavlof Lake and Cannery Pt. (east of Tenakee Springs), 500 acres adjacent to Trap Bay, approximately 3,900 acres between the Kadashan River and Corner Bay, 100 acres on the north side of Long Bay, and scattered locations along Peril Strait. Heavy budworm defoliation on Chichagof Island was again concentrated in the North Arm of Hoonah Sound area, including Moser Island and two large areas north of Patterson Bay (approx. 5,400 ac.). One exception was a 900 acre area of heavy defoliation east of Tonalite Creek (south of Kadashan Bay). Hemlock top-kill and mortality from previous defoliation was evident at Patterson and Crab Bays (approx. 2,200 ac.).

On north Baranof Island, approximately 2,100 acres of light defoliation occurred between Rodman and Saook Bays. An additional 1,200 acres of light defoliation was evident to the west, on Duffield Peninsula. Heavy western hemlock defoliation and associated top-kill was observed in the Blue Lake area east of Sitka (approx. 460 ac.). This area includes the Sawmill Creek Campground, where spruce mortality from needle aphid and spruce beetle has already caused substantial impact.

Budworm defoliation was evident at numerous locations on the mainland north of Frederick Sound. Two consecutive years of heavy budworm and hemlock sawfly defoliation adjacent to Chilkoot Lake (near Haines) resulted in approximately 3,300 acres of mature western hemlock with scattered top-kill and mortality. Budworm defoliation and top-kill (from previous defoliation) were also evident in old-growth western hemlock along the Katzehin River (600 ac.). To the south, light budworm defoliation and top-kill were observed near Pt. Sherman. Approximately 1,200 acres of light defoliation occurred on the west side of Berners Bay. An almost continuous band of intermingled heavy and light defoliation (15,400 and 3,200 acres, respectively) extended from Echo Cove south to Auke Bay. In the Juneau and Douglas areas, light and heavy defoliation totalled 6,100 and 920 acres, respectively. Light defoliation was again evident along Thunder Mountain above Mendenhall and Lemon Creek Valleys. On Douglas Island, light defoliation occurred in the Fish Creek drainage and along the lower elevations of Mount Meek and Mount Ben Stewart.

On the mainland south of Juneau, heavy defoliation occurred south of Greely Pt. (780 ac.) and adjacent to Taku Harbor (700 ac.) Top-kill of western hemlock was also readily apparent at Taku Harbor.
To the south, Snettisham Peninsula had light and heavy defoliation totalling 600 and 1,000 acres, respectively. Top-kill among approximately 100 acres of western hemlock was observed above harvest units near Pt. Hobart. Approximately 1,200 acres of light defoliation occurred at lower elevations near Sandborn Canal, south of Port Houghton. Heavy defoliation totalling 780 acres was observed east of Farragut Bay. Heavy defoliation was again evident in proximity to Horn Mountain, across Frederick Sound from Petersburg.

South of Frederick Sound on the mainland near Wrangell, defoliation was again evident adjacent to Virginia Lake (460 ac., light), east of Madan Bay (1,100 acres, light), along Blake Channel (600 acres, light) together with 150 acres of top-kill from previous defoliation, and north of Bradfield Canal (780 acres of heavy defoliation interspersed with 1,100 acres of light defoliation). Encompassing the Anan Creek wildlife viewing area was approximately 1,500 acres of light budworm defoliation and an additional 930 acres of light defoliation immediately to the south along Ernest Sound (near the location of the first documented black-headed budworm outbreak in SE Alaska, reported in 1917). For the first time during the current outbreak, budworm defoliation was noted on the east side of Cleveland Peninsula; 780 acres (light) and 300 acres (heavy) in proximity to Helm Bay.

Island areas south of Frederick Sound experiencing budworm defoliation included: northwest Kuiu Is. (1,200 ac., light), between Washington Bay and Security Bay; east Kupreanof Island (Lindenberg Peninsula) from Portage Bay south to Green Pt. (5,300 ac., heavy, intermingled with

2,600 ac., light). In this area, top-kill of mature hemlock was apparent on approximately 1,900 ac. east of Petersburg Lake and on 1,200 acres below 2,000 feet (elev.) on Petersburg Mountain. On the west side of Mitkof Island, light defoliation (460 ac.) occurred between Scow Bay and Twin Creek. To the south on Mitkof, top-kill and ongoing light defoliation (100 ac.) were observed on the knob between Big and Falls Creeks. Budworm in association with hemlock sawfly caused approximately 1,400 ac. of top-kill in areas west of Crystal Lake. Light budworm defoliation was observed on Dry Island (460 ac.); just south of Wrangell (100 ac.); also on Wrangell Island south of Thomas Creek (930 ac.); on Deer Is. (460 ac.); on the west side of Zarembo is. (150 ac.); and at scattered locations on Kuiu Is. from McHenry Inlet north to Chichagof Pass (3,500 ac.).

Budworm defoliation noted elsewhere included: 620 acres (light) with scattered top-kill, adjacent to Calder Bay, Prince of Wales Island; 460 ac. (light), south of Vallenar Creek, Gravina Island; and scattered light defoliation (300 ac.) on Revilla Island.

Budworm populations across southeast Alaska were down in 1994, versus 1993, due in part to unfavorable weather conditions early in the summer of 1994. Numbers of black-headed budworm larvae sampled from defoliator plots varied greatly north and south of Frederick Sound. As in 1992 and 1993, numbers of larvae (and acres of defoliation) were consistently higher north of Frederick Sound. The greatest numbers of larvae were collected at Hawk Inlet and Thayer Lake, both on Admiralty Island. Large numbers of larvae were also collected at most sampling sites on Admiralty Island, and at the North Arm of Hoonah Sound (Chichagof Island) and at Saook Bay (north Baranof Island).

South of Frederick Sound, the largest numbers of black-headed budworm larvae were collected at Helm and Yes Bays, both located along Clevelaand Peninsula.

The black-headed budworm outbreak in southeast Alaska is expected to continue in 1995, though at a reduced level. As a whole, budworm populations are not expected to rebound significantly from reductions observed in 1994, though site specific exceptions will occur. Most increases in budworm numbers and their impact in 1995 will likely occur south of Frederick Sound. Two of the impacts of defoliation, top-kill and tree mortality, will continue to be greatest within forests north of Frederick Sound, due to the consecutive defoliation events that have already occurred there.

Observations to date do not indicate significant black-headed budworm-related damage in single cohort stands less than 30 years old (e.g., young-growth stands on eastern Chichagof Island), although this is the subject of a specific study being initiated in 1995. Budworm defoliation does appear to be most pronounced in older stands, growing on moderate-to-high productivity sites and is conspicuously absent on adjoining lower productivity sites (e.g., Fishery Creek, Admiralty Island). Defoliation of young trees (< 20 yrs. old) is most pronounced on such trees where they occur in multi-cohort arrangements, as a component of the understory (e.g., mainland north of Juneau). In 1995 and beyond, studies will continue to evaluate the ecological significance of continued black-headed budworm presence and defoliation to both young and old stands, in actively managed and inactively managed settings.

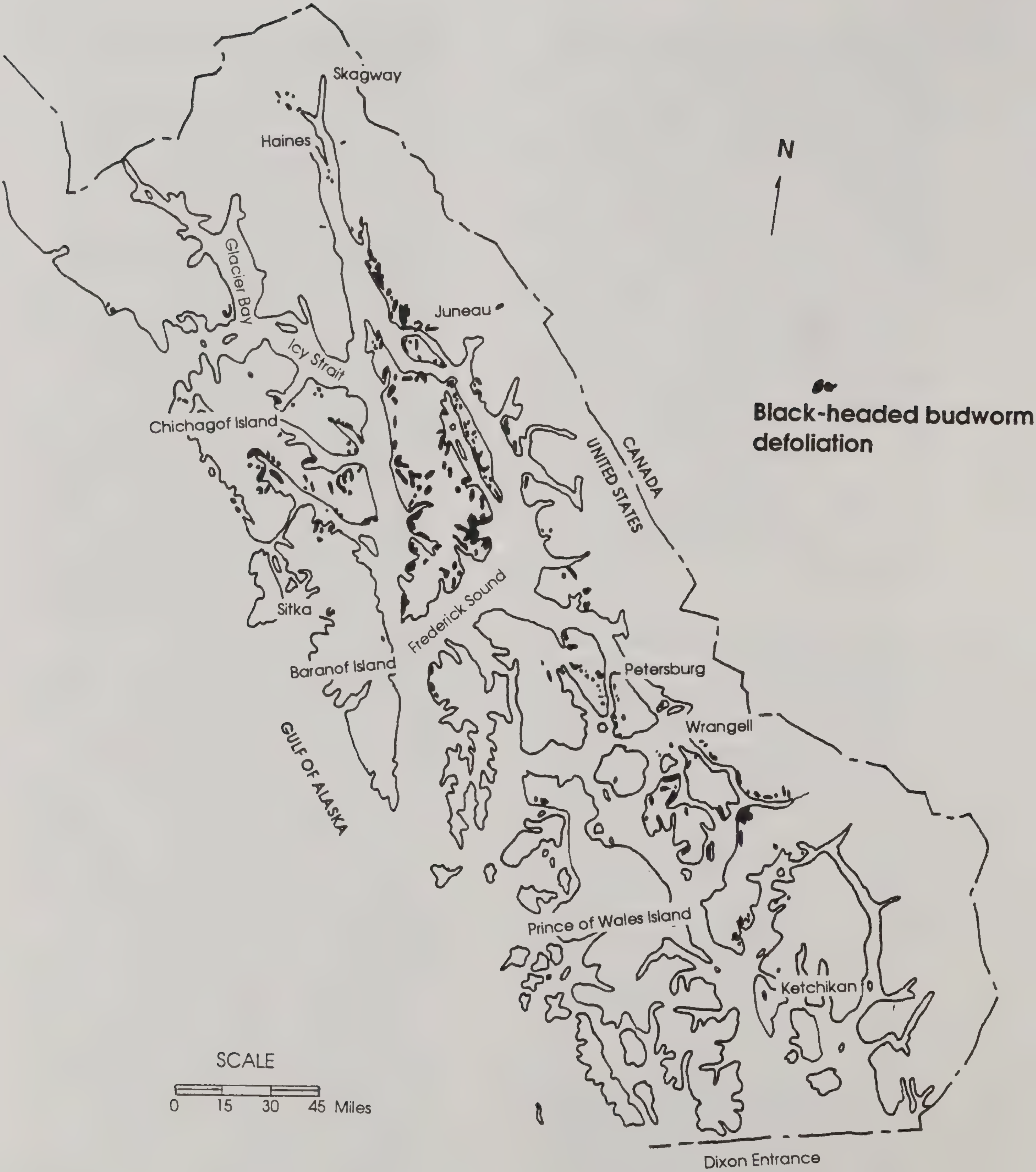

Figure 3. Defoliation of southeast Alaskan forests by the black-headed budworm. Over 193,000 acres of defoliation were mapped in 1994.

HEMLOCK SAWFLY

Neodiprion tsugae Middleton

Hemlock sawflies are common defoliators of western hemlock and are found throughout southeast Alaska. Historically, sawfly outbreaks in southeast Alaska have been larger and of longer duration in areas south of Frederick Sound.

Unlike the larvae of the black-headed budworm, hemlock sawfly larvae feed gregariously, primarily on older hemlock foliage. The two species of insects feeding in combination have the potential to completely defoliate western hemlock. Heavy defoliation of hemlock by sawflies is known to cause reduced radial growth and top-kill. As forest defoliators, hemlock sawflies may ultimately influence both stand composition and structure in some areas. The sawflies themselves are a food source for numerous birds, other insects, and small mammals.

In southeast Alaska, defoliation of western hemlock by hemlock sawfly increased about threefold from 1992 to 1993. However, from 1993 to 1994, sawfly defoliation acreage dropped dramatically, from approximately 19,000 acres to about 3,400 acres. The drop in sawfly populations, like that of the budworm, is at least in part related to weather, although other factors (e.g., biological controls) may also have been involved.

In 1994, the most substantial sawfly activity was documented in conjunction with budworm defoliation at three locations: along the Chilkoot River and adjacent to Chilkoot Lake near Haines (3,300 acres); adjacent to Crab Bay on Chichagof Island (600 acres); and on Mitkof Island west of Crystal Lake (1,400 acres). Top-kill and scattered mortality of western hemlock was observed in these three areas. Heavy defoliation caused primarily by hemlock sawflies was observed at Karta Bay on Prince of Wales Island (50 ac.) and on Revilla Island across Behm Canal from Saks Cove (50 ac.).

Light defoliation by sawflies totalling approximately 3,300 acres was observed: on and adjacent to Long Island (200 ac.); along Twelve Mile Arm (50 ac.), adjacent to McKenzie Inlet (160 ac.), near Cholmondeley Sound (approx. 470 ac.), adjoining Ulloa Channel (50 ac.), and near Canoe Pt., Trocadero Bay (160 ac.), on Prince of Wales Island; along Sukkwan Strait (310 ac.); at Edna Bay and Halibut Harbor on Kosciusko Island (460 ac.); at Princess Bay (250 ac.), Bass Pt. (50 ac.), Thorne Arm (200 ac.), Carroll Inlet (350 ac.), and between Bushy Point and Rockfish Coves (150 ac.) on Revilla Island; and at Short Bay, across from Bell Island (50 ac.).

The highest sawfly larvae counts of the 1994 survey were collected at the North Arm of Moira Sound on Prince of Wales Island and at Thayer Lake on Admiralty Island. Based on sawfly larvae counts and frequency of occurrence in 1994, sawfly populations are expected to slightly increase throughout much of southeast Alaska in 1995.

SPRUCE NEEDLE APHID

Elatobium abietinum Walker

Spruce needle aphids feed on older needles of Sitka spruce, often causing significant amounts of needle drop (defoliation). Aphid defoliation causes reduced tree growth and often predisposes the host to other mortality agents, such as spruce beetle. Likewise,

severe cases of defoliation alone may result in tree mortality. Spruce under stress, such as those in urban settings and those along marine shorelines, are most seriously impacted. Spruce aphids feed primarily in the lower, innermost portions of tree crowns, but may impact entire crowns during outbreaks. Spruce aphid outbreaks in southeast Alaska are usually preceded by mild winters.

Following the mild winter of 1991-92, spruce needle aphid populations in southeast Alaska expanded rapidly, causing over 25,000 acres of Sitka spruce defoliation. Needle aphid populations crashed in 1993, due to extended periods with sub-freezing temperatures during January and February. In 1994, aphid populations began to rebound in and around Sitka, Ketchikan, Craig, and Juneau. In Sitka for example, large numbers of aphids were found actively feeding as late as June. This resurgence of aphid activity will continue to weaken or possibly kill spruce trees previously defoliated during the 1992 needle aphid outbreak.

LARGE ASPEN TORTRIX
Choristoneura conflictana **Wlkr.**

Large aspen tortrix defoliation declined considerably in 1994; 9,836 acres of defoliated aspen were detected this year vs. more than 60,000 defoliated acres in 1993. This decline was most notable in the Yukon Flats area near the Chandalar River where defoliation levels fell from 40,000 acres in 1993 to nothing this year. The Mystery Hills/Round Mountain outbreak on the Kenai Peninsula declined from 2,000 acres in 1993 to fewer than 200 acres of defoliation detected this year.The Mat-Su Valley of south-central Alaska which had more than 10,000 acres of defoliated aspen in 1993 declined to less than 2,000 acres in 1994. The areas of most intense activity in 1994 were located in the Susitna Valley from Willow north to Kashwitna (1,557 acres) and 6,695 acres of aspen were infested 5 miles NE of Flathorn Lake

WILLOW DEFOLIATION

Beginning in 1991, an outbreak of a willow leaf blotchminer, *Micrurapteryx salicifolliela* (Lep:Gracillaridae) occurred for hundreds of miles in the Yukon and Kuskokwim River drainages. Larvae of this miner cause blotches that result in a yellow or reddish discoloration of foliage easily visible from the air. The outbreak worsened in 1992 but subsided to a great extent in 1993, however, certain willow species were still severely infested locally. This insect displays profound host specificity; some intermingled willow species are free of it while others may be severely infested.

The downward trend in willow defoliation continued in 1994. Fewer than 10,000 acres of willow defoliation were detected this year vs. more than 40,000 acres last year. No defoliation was observed along the major tributaries in southwestern Alaska such as the Nushagak, Kuskokwim, or Mulchatna Rivers. Some minor ares of defoliation, however, were noted near Tetlin Junction (50 acres) in interior Alaska and along Eagle River (78 acres) outside of Anchorage.

COTTONWOOD DEFOLIATION
Chrysomela **sp. and** ***Lyonetia*** **sp.**

Defoliation of cottonwood by leaf beetles (*Chrysomela* sp.) and leafminers (*Lyonetia* sp.) is common throughout much of the tree's range in Alaska. Defoliation is most

pronounced near the tops of affected trees. Defoliation is believed to cause reduced tree growth. The biology and overall ecological significance of leaf beetles (*Chrysomela* sp.) in Alaska is not well known.

Cottonwood leaf beetles and leaf miners defoliated 4,221 acres of cottonwood in 1994. In interior Alaska, 1,868 acres of defoliation were noted in the vicinity of the confluence of the Innoko and Yukon Rivers and a smaller area of damage (311 acres) was noted on Great Paimut Island along the Yukon River. Cottonwood leaf beetle activity in southeast Alaska accounted for 2,042 acres. One 700 acre infestation is located near the mouth of the Alsek River within Glacier Bay National Preserve, with several smaller areas scattered within the Russell Fiord Wilderness Area. Another area of approximately 100 acres of defoliation is located near the mouth of the Chickamin River and the balance of the defoliation in southeast Alaska is located in scattered smaller areas along the Chilkat River between Haines and Klukwan.

ALDER DEFOLIATION

For the second consecutive year, defoliation of Sitka alder was prevalent throughout most of southeast Alaska in 1994. At numerous locations, including the immediate Juneau vicinity, many alders were completely stripped of foliage by early August.

Insects causing the defoliation were the striped alder sawfly, *Hemichroa crocea*; the alder woolly sawfly, *Eriocampa ovata*; an aphid, likely *Pterocallis alni*; and a leaf roller, *Epinotia* sp.

The overall ecological significance of these defoliators is not known, but sawflies and leaf rollers are food sources for insectivorous birds and some small mammals. Sawfly and leafroller larvae, as well as aphids are fed upon by predacious insects and and are hosts for some parasitic insect species.

LARCH SAWFLY
Pristiphora erichsonii (Hartig)

Larch sawfly populations significantly declined from the 12,220 acres of defoliation reported in 1993 to 311 acres this year. The only area of defoliation in 1994 is along Little Goldstream Creek approximately 9 miles NNE of Nenana. No defoliation was noted in any of the areas impacted in 1993.

Larch sawfly populations occur wherever there is host material; from Maine to Alaska. Sawfly larvae feed on both eastern and western larch. Effects of heavy defoliation normally result in a reduction in growth rate with little or no mortality occurring. Records collected during a 1955 sawfly outbreak in northern Minnesota indicated that 7 years' moderate to heavy defoliation will kill an occassional larch. The life cycle of the sawfly varies from one to two years. In a 1-year cycle, adults emerge in the spring, lay eggs, and larvae develop throughout the summer. Mature larvae spin to the ground in late summer and enter the duff, spin tough, papery brown cocoons in which they winter. Some larvae spend two winters before they pupate and emerge as adults.

GYPSY MOTH
Lymantria dispar (L.)

The European gypsy moth was accidently introduced into Massachusetts from Europe in 1869 and the rest is history! Since then, the gypsy moth has been responsible for

considerable damage to the hardwood forests of the eastern United States. Millions of dollars are spent annually attempting to reduce the amount of damage and restrict the distribution of this important forest pest. The European gypsy moth also arrived in the western U.S. in the early 1980's.

Historically, there has been little gypsy moth activity in Alaska. In 1985, several larvae were detected by moving company employees on lawn furniture which had been shipped to Juneau from the East Coast. Every summer since 1986, USDA Forest Health Management personnel along with the Cooperative Extension Service and the USDA Animal and Plant Health Inspection Service have placed pheromone monitoring traps throughout Alaska, especially in locations frequented by out-of-state vehicles, including campgrounds and port areas. To date, only two male European gypsy moths have been trapped: one in a campground near Anchorage in 1987 and the other in a campground near Fairbanks in 1992. Due to the recent detection of the Asian gypsy moth, a much more damaging race of the European gypsy moth, in the Pacific Northwest, the Alaskan pheromone trapping program was expanded last year; more than 300 traps were placed throughout Alaska from Petersburg to Nome, including Dutch Harbor in 1994. No Asian or European gypsy moths were encountered. If the Asian gypsy moth becomes established in the western U.S., including Alaska, the potential impacts to forests and riparian areas could be tremendous. The extensive trapping program will be carried out again next year.

SPEAR-MARKED BLACK MOTH
***Rheumaptera hastata* (L.)**

Black moth larvae are a common defoliator on interior Alaska paper birch. From 1974-75, more than 2 million acres of paper birch were infested by epidemic populations of the spear-marked black moth. There is one generation per year with pupae overwintering in the duff-layer. Severe defoliation results in a temporary reduction in radial and terminal growth. Branch dieback is quite common. Repeated defoliation can result in tree mortality.

Black-moth populations significantly declined in 1994; 1,403 acres of defoliated birch were detected this year vs. 5,455 acres in 1993. This year's infestation is located near Harding Lake, approximately 40 miles southeast of Fairbanks as well as a small area of defoliation located along Birch Creek and the Steese Highway.

Figure 4. Spruce beetle-caused mortality near Copper Center, Alaska.

Figure 5. Spruce budworm defoliation near Fairbanks, Alaska.

Figure 6. Wood rotting fungi, particularly *Fomitopsis pinicola,* have rapidly colonized beetle-killed Sitka spruce in lower Glacier Bay, contributing to bole failure and forest gap formation.

Figure 7. Top-kill of young western hemlock due to defoliation by black-headed budworm.

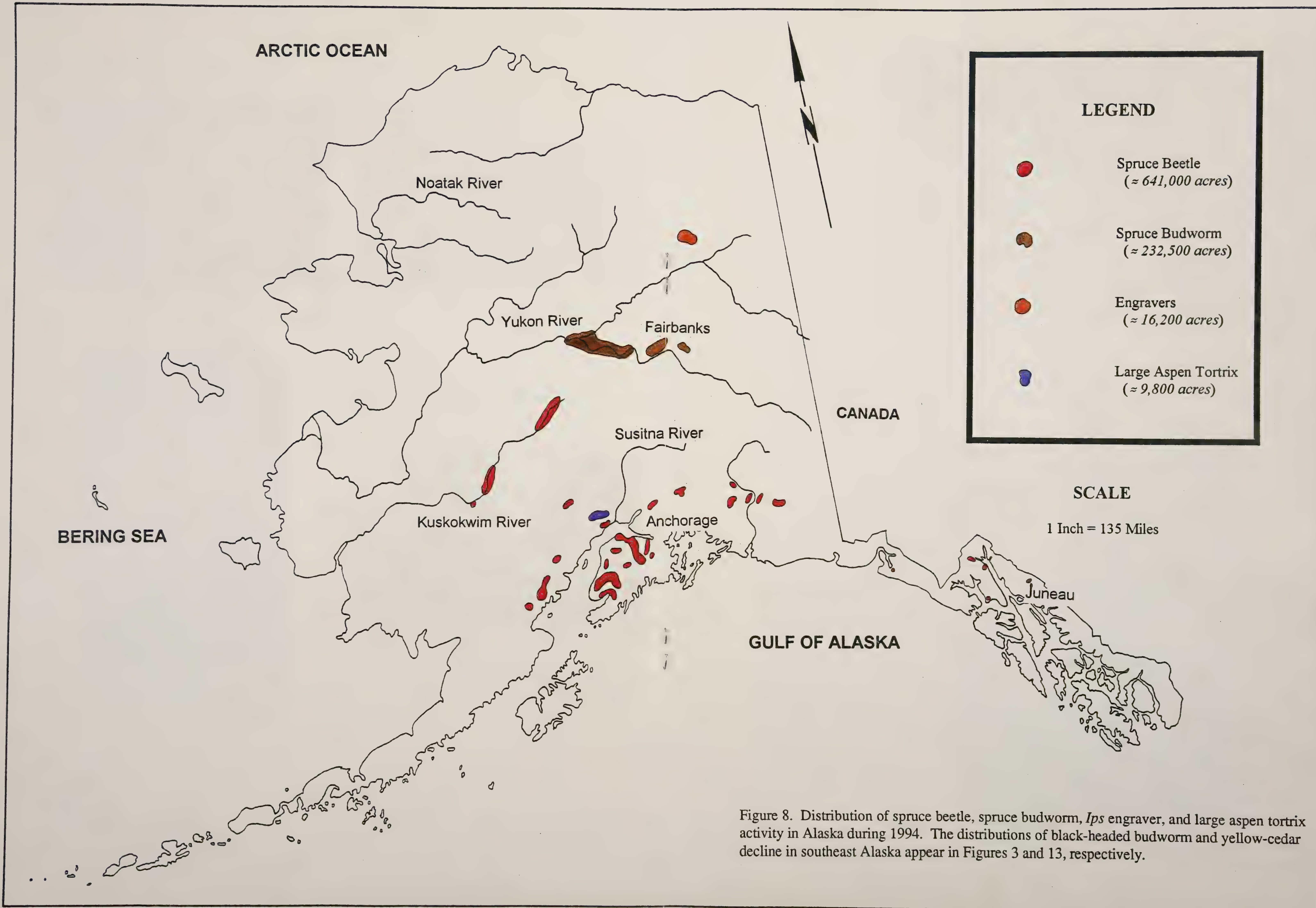

Figure 8. Distribution of spruce beetle, spruce budworm, *Ips* engraver, and large aspen tortrix activity in Alaska during 1994. The distributions of black-headed budworm and yellow-cedar decline in southeast Alaska appear in Figures 3 and 13, respectively.

Figure 9. Heart rot fungi cause enormous volume loss in many productive forests of Alaska. These fungi are also major ecological factors of disturbance in southeast Alaska where they contribute to the maintenance of old-growth forests by initiating bole-breakage, as seen above, which is a leading form of mortality in old trees.

Figure 10. Hemlock dwarf mistletoe causes reduced growth, top-kill, and mortality, but it also provides wildlife habitat and contributes to structural diversity of forests in southeast Alaska.

STATUS OF DISEASES

ECOLOGICAL ROLES OF FOREST DISEASES

The economic effects of forest diseases in Alaska have long been recognized The nearly ⅓ cull in old-growth forests of southeast Alaska caused by heart rot fungi, for example, has been viewed as a severe limitation to the availability and cost of harvesting wood products. The aim of management was to eliminate or reduce disease to minimal levels. But this perspective ignores the functional role of disease in Alaska's forest ecosystems. We are learning that different diseases enhance diversity, provide wildlife habitat, and alter forest structure, composition, and succession. As agents of succession in the western hemlock/Sitka spruce type, diseases are apparently responsible for the "breaking up" of even-aged stands as they are in transition (i.e., 100 to 200 years old) to old-growth phase, and then appear to be the primary factors that maintain the old-growth phase through canopy-gap level disturbance. Thus, diseases are key ecological factors in Alaskan ecosystems.

To reduce disease to minimal levels in all instances is to diminish the various desirable characteristics that they impart and to alter successional patterns. Forest health, therefore, can actually be diminished by zealous disease control. On the other hand, overly abundant levels of some diseases negatively affect nearly all resources. For example, excessive hemlock dwarf mistletoe can lead to canopy collapse in a stand which reduces vertical structure and thermal cover so that even resources such as habitat for most wildlife is reduced.

Two of the principal types of disease that alter forest structure in Alaska, heart rot and dwarf mistletoe, can by managed to desirable levels. If reducing disease to minimal levels is a management objective then both can be largely eliminated for many decades or centuries by clearcut harvesting. If structural and biological diversity are included as objectives for management, then desirable levels of disease can be attained through different strategies of selective harvesting. Most heart rot in coastal stands is associated with natural bole scars. Levels of heart rot can be manipulated by controlling the incidence of bole wounding during stand entries. Levels of dwarf mistletoe can be manipulated through the distribution, size, and infection levels of residual trees that remain after alternative harvests. Based on ongoing research, the effects of different degrees of these two types of diseases will be predictable through time. Thus, one of our objectives in ecosystem management is to develop the tools for managing moderate disease levels that will enhance many resource values but also maintain productivity of the timber resource.

TABLE 2. Suspected effects of common diseases on major ecological characteristics and processes in Alaskan forests. Effects by each disease or disorder are qualified as: - = negligible or minor effect, + = some effect, ++ = dominant effect.

	ECOLOGICAL FUNCTION ALTERED			
DISEASE	STRUCTURE	COMPOSITION	SUCCESSION	WILDLIFE HABITAT
STEM DISEASES				
Dwarf mistletoe	++	+	+	++
Hemlock canker	-	+	-	+
Hardwood cankers	+	+	+	-
Spruce broom rust	+	-	-	++
Hemlock bole fluting	-	-	-	-
Western gall rust	-	-	-	-
HEART ROTS (Many species)	++	+	++	++
ROOT DISEASES (Several species)	+	+	+	+
FOLIAR DISEASES				
Spruce needle rust	-	-	-	-
Spruce needle blights	-	-	-	-
Hemlock needle rust	-	-	-	-
Cedar foliar diseases	-	-	-	-
Hardwood leaf diseases	-	-	-	-
SHOOT DISEASES				
Sirococcus shoot blight	-	-	-	-
Shoot blight of yellow-cedar	-	+	-	-
DECLINES				
Yellow-cedar decline	++	++	++	+
ANIMAL DAMAGE				
Porcupines	+	-	-	+
Brown Bears	+	-	-	+

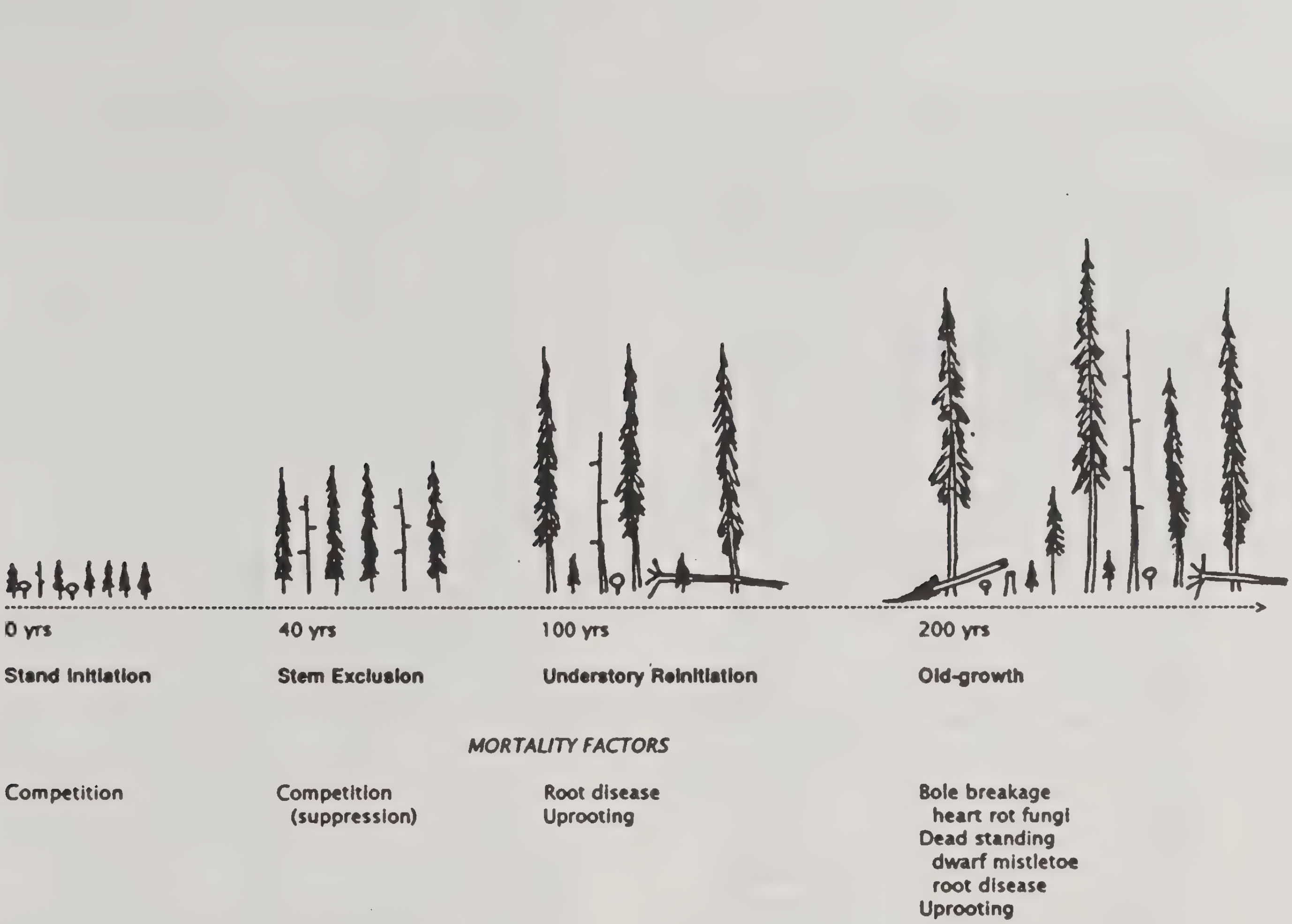

Figure 11. Role of diseases in developmental stages following catastrophic disturbance (e.g., large-scale windthrow, clearcut harvest) in the forests of coastal Alaska. Terms of stand development stages are from Oliver, C. and Larsen, B.C., 1980, Forest Stand Dynamics, McGraw-Hill, New York, 467p. Note the lack of major influence of disease in early successional stages where most mortality is through competition. Numerous diseases are present (e.g., foliar and shoot diseases) at these early successional stages, but none has a predominant effect on forest development. By contrast, diseases appear to be major mortality factors (i.e., disturbance agents) in the understory reinitiation stage. This stage can be interpreted as the transition from even-aged stands breaking up to enter the old-growth stage. Disease appears to be responsible for initiating this change by killing dominant and codominant trees. Heart rot fungi appear to be play a critical role in the maintenance of old-growth by inducing bole breakage which is one of the most common forms of canopy gap level disturbance in old coastal forests. It is conceivable that hemlock dwarf mistletoe intensifies as a stand persists in the old-growth condition for many centuries, reaching such high disease levels that vertical structure and productivity are eroded through time. Thus, the old-growth stage in coastal Alaska may be either sustained by disease in a sort of dynamic equilibrium through the canopy gap process or it may be continually altered until the next catastrophic disturbance. Research is needed to validate the above proposed scenario.

STEM DISEASES

HEMLOCK DWARF MISTLETOE
Arceuthobium tsugense (Rosendhal) G.N. Jones

Hemlock dwarf mistletoe is the most important disease of western hemlock in unmanaged, old-growth stands throughout southeast Alaska as far north as Haines. Within the range of western hemlock, dwarf mistletoe is absent from Cross Sound to the northwest along the Gulf of Alaska. The incidence of dwarf mistletoe varies in old-growth hemlock stands in southeast Alaska from stands in which almost every western hemlock tree is severely infected to other stands in which the parasite is absent. Infection of Sitka spruce is uncommon and infection of mountain hemlock is rare. The disease is uncommon on any host above elevations of 500 feet or so. Heavily infected western hemlock trees have branch proliferations (witches-brooms), bole deformities, reduced height and radial growth, less desirable wood characteristics, top-kill, and severely infected trees may die.

These are all potential problems in stands managed for wood production. Growth loss in heavily infested stands can reach 40%. On the other hand, witches-brooms, wood decay associated with bole infections, and scattered tree mortality can result in greater diversity of forest structure and increased animal habitat. Witches-brooms may provide hiding or nesting habitat for birds or small mammals. The inner bark of swellings and the seeds and shoots of the parasitic plants are nutritious and often consumed by small mammals. Heavily infected hemlock stands can begin to decline and collapse to the extent that diversity and animal habitat are diminished, however. Stand composition is altered when mixed-species stands are heavily infected; growth of resistant species such as Sitka spruce and cedar is enhanced.

Spread of the parasite into young-growth stands is typically by: 1) infected non-merchantable hemlock trees (residuals) which are sometimes left standing in cut-over areas, 2) infected old-growth hemlocks on the perimeters of cut-over areas, and 3) infected advanced reproduction. Residual trees may play the most important role in the initial spread to young stands. Managers using alternative harvest techniques (e.g., large residuals left standing in clearcuts, small harvest units, or partial harvests) should recognize the increased impact of dwarf mistletoe in hemlock overstory trees and in regeneration that resulted from partial disturbances such as windthrow and selective

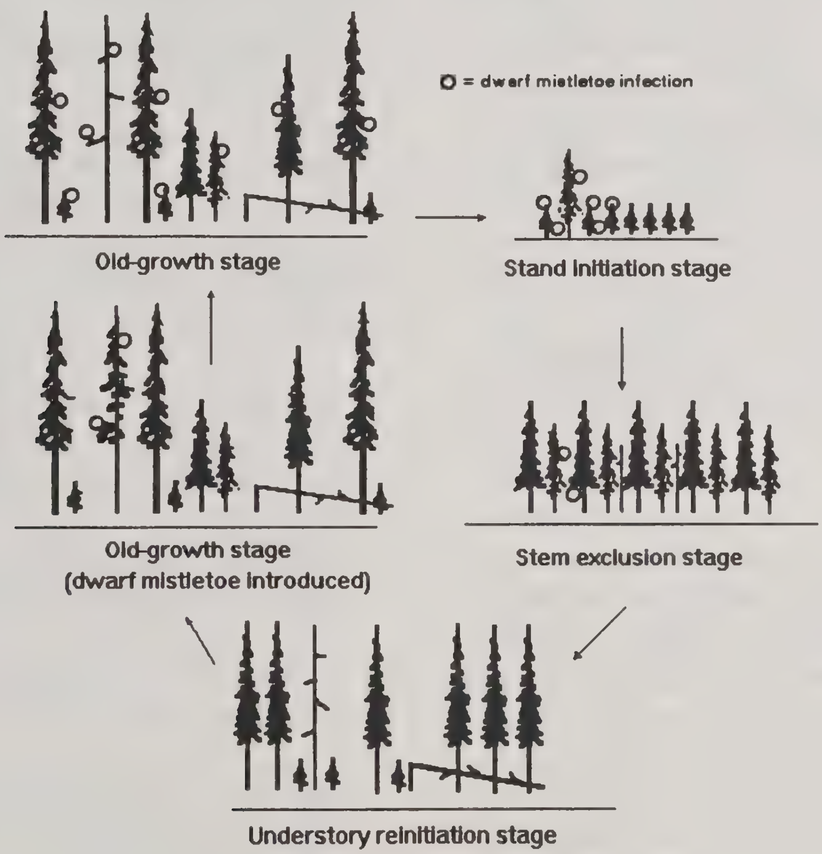

Figure 12. Effects of major disturbance (e.g., catastrophic wind damage or clearcutting) on hemlock dwarf mistletoe in southeast Alaska. Dwarf mistletoe is largely eliminated in the early stages of even-aged stands through shading and the inability of the parasite to spread vertically as fast as hemlocks grow in height. Through this process of stand development, dwarf mistletoe may be eradicated from the site for a very long time (e.g., many centuries) until it is reintroduced by birds. Once established in old-growth, dwarf mistletoe flourishes because its efficient mechanism for short distance spread, explosively discharged seeds, is favored by the pattern of small canopy-gap disturbance.

harvesting. It is becoming clear that selective harvesting techniques will be the method for maintaining desirable levels of disease as management objectives emphasize structural and biological diversity.

HEMLOCK CANKER
Xenomeris abietis Barr. and other fungi

Hemlock canker, which occurred at outbreak levels for the previous four years, finally subsided in 1994. It had been conspicuous along unpaved roads on Prince of Wales Island, Kuiu Island (Rowan Bay road system), Chichagof Island (Corner Bay road system) and near Carroll Inlet on Revillagigedo Island. It was also observed in several unroaded areas. Infection of new trees was infrequent in 1994 and affected areas now have the grey appearance of recently-killed hemlocks in the lower and mid canopy levels.

The causal agent has not been conclusively determined. The fungus *Xenomeris abietis* is sometimes associated with dead hemlock, but another unidentified imperfect fungus has been more frequently isolated from cankered tissues. The role of road dust in the disease is also now questioned as hemlock canker was found well away from roads. It is still conceivable that dust is a contributing factor in the disease, although not absolutely necessary for its development.

Ecologically, stand composition and structure are the primary effects of hemlock canker. Tree species other than western and mountain hemlock are resistant and favored by the disease. Wildlife habitat, particularly for deer, may be enhanced where the disease kills understory hemlock which out-competes the more desirable vegetation.

SPRUCE BROOM RUST
Chrysomyxa arctostaphyli Diet.

Broom rust is common throughout interior and southcentral Alaska but is found in only several local areas of southeast Alaska (e.g., Halleck Harbor area of Kuiu Island and Glacier Bay). The disease is abundant only wherever spruce grows near the alternate host, bearberry or kinnikinnik (*Arctostaphylus uva-ursi*) in Alaska. The fungus cannot complete its life cycle unless both host types (spruce and bearberry) are present.

Infections by the rust fungus result in dense clusters of branches (witches brooms) on white, Lutz, Sitka, and black spruce. The incidence of spruce broom rust changes little from year to year.

The disease may cause slowed growth on spruce, although this has not been determined by research. The dense clusters of branches and needles (brooms) are known to provide nesting and hiding habitat for some birds and perhaps for small mammals.

WESTERN GALL RUST
Peridermium harknessii J.P. Moore

Infection by the gall rust fungus *P. harknessii* causes spherical galls on branches and main boles of shore pine. The disease was common throughout the distribution of pine in Alaska in 1994. Infected pine tissues are swollen but are not always killed by the rust fungus. Another fungus, *Nectria macrospora*, colonized and killed many of the pine branches with these galls this year. The combination of the rust fungus and *N. macrospora* commonly caused top-kill. Even though very abundant, the disease does not appear to have major ecological effect in Alaskan forests.

HEART ROT DECAYS

HEART ROTS OF CONIFERS

Heart rot decay cause enormous loss of wood volume in Alaskan forests. For example, roughly ⅓ of the old-growth timber volume in southeast Alaska is defective because of heart rot fungi. These extraordinary effects occur where long-lived tree species predominate in old-growth forests in southeast Alaska. The great longevity of individual trees allows ample time for the slow-growing decay fungi to cause significant amounts of decay. Wood decay fungi play an important role in the structure and function of coastal old-growth forests where fire and other forms of catastrophic disturbance are uncommon. By predisposing large old trees to bole breakage, these fungi serve as important disturbing factors that cause small-scale canopy gaps. Heartrot fungi enhance wildlife habitat -- indirectly by increasing forest diversity through gap formation and more directly by creating hollows in logs or live trees for species such as cavity nesting birds.

The importance of decay fungi in managed young-growth conifer stands is less certain. Wounds on live trees caused by logging activities allow for the potential of decay fungi to cause appreciable losses. Studies in progress are investigating how frequently fungi enter wounds of different sizes and the rate of subsequent decay in these wounded trees. Preliminary results indicate that heart rot development is much slower in southeast Alaska than where it has been studied in the Pacific Northwest.

In southeast Alaska, the following fungi are the most important causes of wood decay in live trees:

<u>Sitka spruce</u>
Fomitopsis pinicola
Phellinus pini
Armillaria sp.
Phaeolus schweinitzii
Laetiporus sulphureus

<u>Western hemlock</u>
Fomitopsis pinicola
Armillaria sp.
Heterobasidion annosum
Laetiporus sulphureus
Phaeolus schweinitzii
Phellinus hartigii
Phellinus pini

<u>Western redcedar</u>
Poria albipellucida
Phellinus weirii

With the exception of *Armillaria* sp., all decay fungi important on Sitka spruce are also important in the decay of white spruce in south-central and interior Alaska and on Lutz spruce on the Kenai Peninsula. In addition, significant volume loss occurs in white and Lutz spruce from butt rot caused by *Coniophora puteana* and *Pholiota alnicola.*

Wood decay fungi decompose branches, roots, and boles of dead trees; therefore, they play an essential role in recycling wood in forests. However, saprot decay also routinely and quickly develops in spruce trees attacked by spruce bark beetles. Large volumes of potentially recoverable timber volume are currently being lost annually on the Kenai Peninsula, where salvage logging has not kept pace with tree mortality from the continuing spruce beetle epidemic.

Significant volume loss from saprot and heartrot appears to begin about 4-5 years following tree death. Several species of saprot fungi are associated with spruce beetle-caused mortality with *Fomitopsis pinicola* being the most common.

HEART ROTS OF HARDWOODS

Heart rots are the most important cause of volume loss in Alaskan hardwood species. Incidence of heartrot in hardwood species of interior and south-central Alaska is generally high by the time a stand has reached maturity (about 50 years old). Substantial volume loss can be expected in stands 80 years old or older. Decay fungi will limit rotation ages if these hardwood forests are ever managed for wood production. Detailed data on volume losses by stand age class and forest type are currently lacking; studies are needed to better characterize these relationships.

Pleurotus sp. and *Pholiota* sp., which produce annual sporophores, commonly occur on trembling aspen, black cottonwood, and paper birch, but are not as common as heartrot fungi that form perennial sporophores on these tree species. *Phellinus igniarius* (L. ex Fr.) Quel. and *Fomes fomentarius* (Fr.) Kichx. account for the majority of decay in paper birch, with the former stem decay fungus being the most important in terms of both incidence and decay volume. *Phellinus tremulae* (Bord.) Bond & Boriss. accounts for the majority of stem decay in both trembling aspen. A number of fungi cause heart rot in balsam poplar, cottonwood, and other hardwood species in Alaska.

SHOOT DISEASES

SIROCOCCUS SHOOT BLIGHT
Sirococcus strobilinus **Pruess.**

Young-growth western hemlock shoots were killed in moderate levels by the blight fungus *S. strobilinus* in southeast Alaska this year. Sitka spruce and mountain hemlock are sometimes also attacked. Thinning may be of some assistance in reducing damage by the fungus as thinned stands have fewer infections than unthinned stands.

This disease is typically of minimal ecological consequence because infected trees are not often killed and young hemlock stands are so densely stocked. Species composition may be altered to some degree where trees other than western hemlock may be favored by the disease.

SHOOT BLIGHT OF YELLOW-CEDAR
Apostrasseria sp.

Yellow-cedar regeneration suffered substantial infection and shoot blight by the fungus *Apostrasseria* sp. in southeast Alaska in 1994 as it does every year. The disease does not affect mature cedar trees, however. Attack by the fungus causes terminal and lateral shoots to be killed back 10 to 20 cm or so on seedlings and saplings during winter or early spring. Entire seedlings up to 0.5 m tall are sometimes killed. The newly discovered fungus that causes the disease, *Apostrasseria* sp., is closely related to other fungi that cause disease on plants under snow. The fungus *Herpotrichia juniperi* is often found as a secondary invader on seedlings after they die. An inoculation study was underway in 1994 to confirm the

pathogenicity of *Apostrasseria* sp. and the saprophytic nature of *Herpotrichia.*

This shoot blight disease probably has more ecological impact than similar diseases on other host species because the natural regeneration of yellow-cedar is limited in many areas. By killing the leaders of yellow-cedar seedlings and diminishing their ability to compete with other vegetation, this disease reduces the regeneration success of yellow-cedar and thereby alters species composition.

FOLIAR DISEASES

SPRUCE NEEDLE BLIGHTS

Lirula macrospora (Hartig) Darker
Rhizosphaera pini (Corda) Maubl.
Lophodermium picea (Fuckel) Höhn.

The fungus *Lirula macrospora*, which is the most important needle pathogen of Sitka spruce occurred at moderate levels in 1994. It was most common on young Sitka spruce and the lower crowns of larger trees throughout coastal Alaska. *Lophodermium picea* was present at low infection levels in 1994. This disease is more typical of larger, older trees of all spruce species in Alaska. *Rhizosphaera pini* was found for the second consecutive year at damaging levels in coastal Alaska where it was killing the lower, inner crown of Sitka spruce in several areas around Juneau. Damage closely resembles that caused by spruce needle aphid and microscopic observation of the tiny fruiting bodies on infected needles is necessary for proper identification.

The primary impact of these needle diseases is one of appearance. They have only negligible ecological consequence. Repeated heavy infections may slow the growth of spruce and benefit neighboring trees, thereby altering species composition to some degree.

SPRUCE NEEDLE RUST

Chrysomyxa ledicola Lagerh.
Chrysomyxa weirii Jacks.

Spruce needle rust, caused by *C. ledicola*, occurred at moderate and high levels in 1994. The disease was noted as abundant on poorly drained sites near Petersburg, Juneau, and other areas in southeast Alaska. The disease occurred at low levels on white and Lutz spruce in interior and southcentral Alaska in 1994.

The spores that infect spruce needles are produced on the alternate host, Labrador-tea (*Ledum* spp.), a plant that is common in boggy areas; thus the disease on spruce is most pronounced in these boggy (muskeg) areas. Although the disease can give spruce trees the appearance of being nearly dead, trees rarely die from this disease even in years of intense infection.

On Sitka spruce, the primary ecological consequence of the disease may be to reduce tree vigor of a species already poorly adapted to boggy sites. Repeated infection of spruce in may alter forest composition by favoring other tree species.

In 1994 the fungus *C. weirii* occurred in Juneau and other areas of southeast Alaska at the most damaging levels ever recorded. *C. weirii* produces fruiting bodies on one-year old needles of Sitka spruce in early spring. Its spores infect Sitka spruce needles and no alternate host is involved. Even at these historically high infection levels, there is little ecological or economic impact.

HEMLOCK NEEDLE RUST
Pucciniastrum vaccinii (Rab.) Joerst.

Hemlock needle rust was present at low, endemic levels on needles of western hemlock in 1994. The disease has not been found at outbreak levels since the late 1970's. Infection levels are rarely significant enough to cause any major ecological change.

FOLIAGE DISEASES OF CEDARS
Gymnosporangium nootkatense Arth.
Didymascella thujina (Durand) Maire

Two fungi that infect the foliage of cedar, *G. nootkatense* on yellow-cedar and *D. thujina* on western redcedar, occurred at endemic levels this year. *D. thujina* was the more damaging of the two and was common wherever its host was found. Infection by neither fungus resulted in severely defoliated nor death of cedar trees. Neither disease has major ecological effects.

DECLINES AND ABIOTIC FACTORS

YELLOW-CEDAR DECLINE

Decline and mortality of yellow-cedar persists as one of the most spectacular forest problems in Alaska. About 578,000 acres of decline have been mapped during aerial detection surveys. Concentrated mortality occurs in a wide band from western Chichagof and Baranof Islands to the Ketchikan Area.

All research suggests that no contagious organism is the primary cause for this extensive mortality. Some abiotic (non-living) site factor, probably associated with the poorly-drained anaerobic soils where decline occurs, appears to be responsible for initiating and continuing cedar decline. Two hypotheses have been proposed to explain the primary cause of cedar decline -- death could result from (1) toxins produced by anaerobic decomposition in the wet, organic soils or (2) freezing damage to shallow fine roots in wet soils associated with climatic warming and reduced insulating snowpacks in the last century. These hypotheses are developed in some detail (Hennon and Shaw 1994). Whatever the primary cause of this mysterious decline, it is probably a naturally-occurring phenomenon.

A list of acreage affected by Alaska-yellow cedar decline has been determined from a composite map developed by mapping dead and dying cedar during annual aerial detection surveys conducted over previous years. Research suggests that the total acreage of yellow-cedar decline has been increasing very gradually; the slow increase in area has been a result of the expansion of existing decline (<3 feet/year) into adjacent stands. Contained within most declining stands are trees that died up to 100 years ago (snags still standing), more recently killed yellow-cedars, dying yellow-cedars (with yellow, red, or thinning crowns), healthy yellow-cedars, and other tree species.

Ground surveys indicate that 65% of the basal area of yellow-cedar is dead on this acreage. Other tree species are affected in different ways: on some sites they produce increased growth, presumably due to less competition from cedars and on other sites they experience slowed growth and mortality

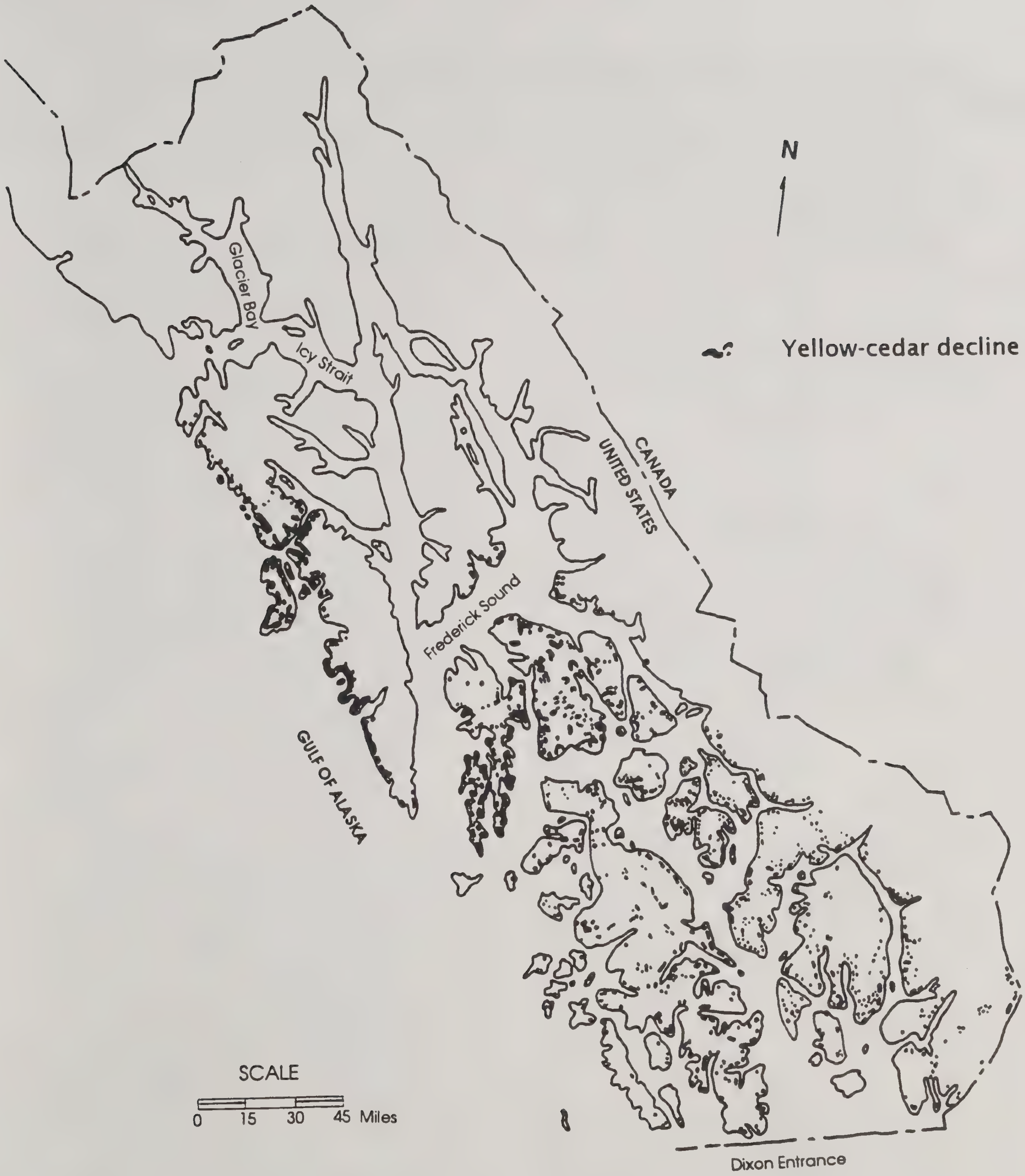

Figure 13. Distribution of yellow-cedar decline in southeast Alaska

Table 3. Acreage affected by yellow-cedar decline in southeast Alaska in 1994.

	Acres
NATIONAL FOREST LAND	550,381
Chatham Area	133,213
Juneau Ranger District	1,167
Hoonah Ranger District	2,179
Sitka Ranger District	
Chichagof I	37,520
Baranof I	58,564
Kruzof I	27,971
Total	124,055
Admiralty Island Nat'l Mon. Wilderness	5,812
Stikine Area	237,141
Petersburg Ranger District	
Kupreanof I	80,069
Kuiu I	67,276
Mitkof I	8,602
Woewodski I	2,258
Mainland	8,797
Total	167,002
Wrangell Ranger District	
Etolin I	26,233
Wrangell I	16,648
Zarembo I	9,496
Woronofski I	622
Mainland	17,140
Total	70,139
Ketchikan Area	180,027
Thorne Bay Ranger District	
Prince of Wales I	29,204
Kosciusko I	14,518
Heceta I	1,463
Total	45,185

	Acres
Ketchikan Area (continued)	
Craig Ranger District	
Prince of Wales I	43,020
Dall I. and Long I	1,479
Total	44,499
Ketchikan Ranger District	
Revillagigedo I	24,831
Gravina I	6,780
Mainland	22,028
Total	53,639
Misty Fjords Nat'l Mon. Wilderness	
Revillagigedo I	13,623
Mainland	23,081
Total	36,704
NATIVE LAND	17,667
Prince of Wales I	10,196
Kupreanof I	312
Sukkwan I	156
Ketchikan area	5,058
Annette I	1,945
STATE AND PRIVATE LAND	10,430
Sitka area	1,246
Mitkof I	1,362
Kupreanof I	234
Prince of Wales I	943
Wrangell area	311
Pelican area	156
Ketchikan area	2,131
Gravina I	2,958
Kosciusko I	1089
TOTAL LAND AFFECTED	**578,478**

because of site deterioration (poor drainage). Succession to western hemlock and mountain hemlock appears to be occurring in some stands where decline has occurred for up to almost a century.

Little is known about wildlife use and dependency of yellow-cedar forests, whether these forests are experiencing excessive mortality or not. The primary ecological effect of yellow-cedar decline is to alter stand structure (i.e., addition of numerous snags), composition (i.e., yellow-cedar diminishing and other tree species becoming more numerous), and the eventual succession to other conifer species. The creation of numerous snags is not particularly beneficial to cavity-using animals because of the decay resistance of yellow-cedar wood. Region-wide, this excessive mortality of yellow-cedar may lead to diminishing populations (but not extinction) of yellow-cedar, particularly when the poor regeneration of the species is considered.

HEMLOCK FLUTING

Deeply incised grooves and ridges extending vertically along boles of western hemlock characterize hemlock fluting. Bole fluting is common on western hemlock throughout southeast Alaska. This condition reduces the value of hemlock logs because they yield less sawlog volume and bark is contained in some of the wood. The cause of fluting is not completely known, but associated factors include increased wind-firmness of fluted trees, common occurrence on sites with shallow soils, triggering of fluting by growth release, and fluting patterns on boles that follow translocation. The asymmetrical radial growth appears to be caused by unequal distribution of carbohydrates caused by the presence of dead branches.

Researchers have documented the development of fluting in young hemlock stands that regenerated following clearcut harvesting or other disturbance. After several centuries, fluting is no longer outwardly visible in some trees because they have attained more equal translocation and fluting patterns have been engulfed within the stem.

Bole fluting has important economic impact, but probably does not have much ecological consequence beyond adding to windfirmness.

BLOWDOWN

A considerable area of Sitka spruce blowdown was observed near the mouth of the Bering River approximately 55 miles east of Cordova. Blowdown totaled 2,569 acres. Current spruce beetle activity along the Taku River in southeast Alaska was noted in association with a 600 acre blowdown event that occurred in 1990.

WATER DAMAGE

Two significant areas of high water damage were observed in interior Alaska in 1994. One area of flood damage apparently killed 623 acres of spruce at Egypt Mountain approximately 5 miles SE of Farewell Lake Lodge and a 245 acre area of flood-killed birch was observed approximately 2 miles E of Manley Hot Springs along the Tanana River.

Water damage to vegetation on a smaller scale is common annually throughout southeast Alaska, due primarily to elevated or perched water tables and spring runoff and to a lesser degree from beaver activity.

STATUS OF ANIMAL DAMAGE

PORCUPINE
Erethizon dorsatum

Porcupines cause severe damage to Sitka spruce and western hemlock in numerous local areas of southeast Alaska. An extensive survey documents the level of porcupine damage in young-growth stands. Feeding injuries to trees are confined to the known distribution of porcupine; thus, trees are not damaged where the porcupine is absent such as Prince of Wales, Kuiu, Baranof, Chichagof, and Admiralty Islands. Damage is especially serious on Mitkof Island in southeast Alaska. Other damage has been noted at Thomas Bay, Cleveland Peninsula, Bradfield Canal, Anita Bay, Douglas Island, and the Juneau area. Shore pine near Haines has been damaged the last few years. Porcupines also damage trees throughout interior Alaska where bark beetles, including *Ips* spp., have been found infesting damaged trees.

In southeast Alaska, feeding behavior of porcupines changes as forests age and trees become larger and older. Porcupines climb smaller trees and kill or cause topkill by removing bark along the entire bole, or the bole near the top of the tree. As trees become larger, around 40-50 years old, porcupines climb fewer trees and most of the damage is in the form of basal wounding. Most of these larger trees are not killed, but the large basal scars allow fungi to enter the bole and begin to cause wood decay.

The primary ecological consequences of porcupine feeding are: (i) to provide greater diversity of structure and vegetation in young-growth even-aged conifer stands through aggregated tree mortality and (ii) to provide greater levels of heart rot decay by the creation of infection courts (wounds) in older trees.

BROWN BEAR
Ursus arctos

Yellow-cedar trees were wounded by brown bears in spring on Baranof and Chichagof Islands. Brown bears rip the bark away from the lower boles of these trees, apparently to taste the sweet cambium. Other tree species are unaffected. Trees with old scars have associated columns of wood decay that will limit the value of their butt logs. Ecologically, this interaction of bears and trees may benefit the bears directly by providing nourishment. In addition, stand structure may be altered by greater heart rot levels due to bole wounding.

INTEGRATED PEST MANAGEMENT ACTIVITIES

Integrated pest management has been described as a "systems approach to alter pest damage to acceptable levels through a variety of techniques, including predators and parasites, genetically resistant hosts, natural environmental modifications, and when necessary and appropriate, chemical pesticides." Current IPM activities in Region 10 include:

(1) Participation in a cooperative effort with the Alaska Agricultural Research Station and the Cooperative Extension Service to provide pest management information to Alaska residents. The program, which includes education, research and survey activities, and provides integrated pest management information concerning urban forestry and garden and greenhouse pests. The IPM Technician Program provides the principles of integrated pest management to the Alaska public through the expertise and activities of the Technicians. The program is educational in nature and provides the public with a means to learn about pest management in an informal and accessible manner. IPM Technicians were located in Anchorage, Palmer, Soldotna, Fairbanks, Delta Junction, Juneau, Ketchikan (new in 1994), and Kodiak. They also served surrounding communities within their districts. The Anchorage and Soldotna sites both had a full time and a half time Technician; the remaining locations had one IPM Technician for the season. The total recorded client contacts reached well over 3,500 which was more than 50% of all contacts made by the Cooperative Extension Service. This successful outreach results largely from the Technicians enthusiastic and professional approach. As more Alaskans become informed of the availability and services of the IPM Technician Program, the Technicians, as part of the statewide ACEIPM program, will continue to provide the most current and accessible pest identification and management information available. Each IPM Technician conducted at least one field workshop during the 1994 season and had at least one contact with the media. Four issues of "The IPM Scout" were produced and distributed without charge to more than 2,500 subscribers . In addition each IPM Technician submitted four monthly area reports and one feature article during the course of the season.

(2) Ground applications of methylcyclohexenone (MCH) for the prevention of spruce beetle attacks and population build-up in standing, uninfested spruce were undertaken in the spring of 1994. MCH is the naturally occurring antiaggregating pheromone of the spruce beetle. That is, it functions as a repellent. The objective of the study was to see if the application of MCH in a Bubble-cap formulation would significantly reduce the number of spruce beetle attacks and subsequent brood production on large diameter standing spruce. The use of MCH bubble caps, however, appears feasible as an operational use strategy for protecting high value stands of spruce where spruce beetle populations are low, but increasing. Bubble caps applied to standing trees at a density of 25 and 50 bubble caps/acre protected the treated trees compared to the untreated control plots.

In southeast Alaska, similar trials were conducted near Haines in standing and windthrown Sitka spruce. Spruce beetle pressure was not adequate to draw

conclusions among the standing trees. The exact opposite was true among the windthrown trees, where all treated and control trees experienced substantial beetle attack.

(3) The current black-headed budworm outbreak in southeast Alaska is impacting trees in both forest and urban settings. A study was initiated in the Juneau area in 1993 to assess the value of insecticide implants in protecting individual spruce and hemlock from defoliation by the black-headed budworm. The impact of some natural control agents is also being assessed. The two-year study was completed in 1994. Preliminary results indicate that use of insecticide implants were successful in reducing both amount and severity of defoliation. Data analysis is ongoing to determine differences (if any) between timing of implant treatments.

Insecticide implants have been found to be a safe and effective method for protecting high value trees (e.g. seed orchard trees, ornamentals, and trees in recreation areas) against the negative impacts of several insect species.

(4) Carbaryl is one of the most frequently used pesticides for prevention of spruce beetle attacks on standing spruce. One application of a 2% formulation provides almost three years of protection. However, carbaryl is not an effective pesticide for other species of *Dendroctonus*, specifically the southern pine beetle. Environmental fate studies with respect to carbaryl were initiated the last three years in Alaska, California, and North Carolina. The objectives of these studies are: a) delineate the persistence of carbaryl on the bark of loblolly pine and Lutz spruce, and b) determine the effects of climatic factors on the movement of carbaryl in forest litter and soils in wet and dry sites in three different ecosystems and geographic areas of North America.

SUBMITTING INSECTS AND DISEASES FOR IDENTIFICATION

The following procedures for the collection and shipment of specimens should be used for submitting samples to specialists:

I. Specimen collection:

1. Adequate material should be collected
2. Adequate information should be noted, including the following:
   a. Location of collection
   b. When collected
   c. Who collected the specimen
   d. Host description (species, age, condition, # of affected plants)
   e. Description of area (e.g., old or young forest, bog, urban);
   f. Unusual conditions (e.g., frost, poor soil drainage, misapplication of fertilizers or pesticides?).
3. Personal opinion of the cause of the problem is very helpful.

II. Shipment of specimens:

1. General: Pack specimens in such a manner to protect against breakage.
2. Insects: If sent through the mail, pack so that they withstand rough treatment.
   a. Larvae and other soft-bodied insects should be shipped in small screw-top vials or bottles containing at least 70% isopropyl (rubbing) alcohol. Make certain the bottles are sealed well. Include in each vial adequate information, or a code, relating the sample to the written description and information. Labels inserted in the vial should be written on with pencil or India ink. Do not use a ballpoint pen, as the ink is not permanent.
   b. Pupae and hard-bodied insects may be shipped either in alcohol or in small boxes. Specimens should be placed between layers of tissue paper in the shipping boxes. Pack carefully and make certain that there is very little movement of material within the box. Do not pack insects in cotton.
3. Needle or foliage diseases: Do not ship in plastic bags. Sprinkle lightly with water before wrapping in newspaper. Pack carefully and make sure that there is very little movement of material within the box. Include the above collection information. For spruce and other conifers, include a description of whether current year's-needles, last-year's needles, or old-needles are attacked.
4. Mushrooms and conks (bracket fungi): Do not ship in plastic bags. Either pack and ship immediately, or first air dry and then pack. To pack, wrap specimens in dry newspaper and pack into a shipping box with more newspaper. If on wood, include some of the decayed wood. Be sure to include all collection information.

III. Shipping:

1. Ship as quickly as possible, especially if specimens are fresh and not air-dried. If samples cannot be shipped rapidly, then store in a refrigerator.
2. Include address inside shipping box.
3. Mark on outside: "Fragile: Insect-disease specimens enclosed. For scientific purposes only. No commercial value."

FOREST INSECT AND DISEASE BIOLOGICAL EVALUATIONS, TECHNICAL REPORTS, AND MISCELLANEOUS PUBLICATIONS

Alaska Division of Forestry and USDA Forest Service. 1994. Alaska Forest Insect and Disease Survey Maps--1993. GIS Map Product., Anchorage, AK., Misc. Publ. 62p.

Bettini, L. 1994. Eriophyid Mites. Alaska Cooperative Extension Service and USDA Forest Service, Alaska Region Pamphlet 100C-1-006. 8p.

Backman, R.; Mask, R. 1994. Defoliators of Western Hemlock, An Aerial Survey Perspective. In Proceedings," Aerial Pest Detection and Monitoring Workshop", April 25-29, 1994, Las Vegas, NV. 3 pp.

Burnside, R. 1994. Alaska forest health and the spruce beetle, with emphasis on lands acquired from Seldovia Native Association, Inc. Southside Kachemak Bay. Alaska Division of Forestry, Anchorage, AK 3p.

Hennon, P.E. 1994. Can a shoot blight disease alter forest composition? Western International Forest Disease Work Conference. 8-11 March 1994. Albuquerque, NM.

Hennon, P.E. 1994. *Chamaecyparis nootkatensis*. In: eds., Schutt, Schuck, Aas, Lang, Enzyklopadie der Holzgewachse. Ecomed Verlag, Landsberg, Germany.

Hennon, P.E. 1994. Decay fungi--indicators of tree defect in southeast Alaska. USDA Forest Service, Juneau, AK. R10-TP-47. Color illustrated card set.

Hennon, P.E.; Mask, R. 1994. Forest health evaluation, Sitka National Historical Park. USDA Forest Service, State and Private Forestry, Juneau, AK. Forest Health Biological Evaluation R10-TP-41. 15p.

Hennon, P.E; Mask, R.; Holsten, E.H. 1994. Forest insect and disease conditions in Alaska, 1992. Forest Health Management Report R10-TP-32, State and Private Forestry, USDA Forest Service. Juneau, AK. 36p.

Hennon, P.E.; Shaw, C.G. III 1994. Did climatic warming trigger the onset and development of yellow-cedar decline in southeast Alaska? European Journal of Forest Pathology, Vol. 24.

Holsten, E.H. 1994. Bibliography/Alaska Region, Forest Health Management, USDA For. Ser., Alaska Region, Anchorage, AK. Forest Health Management Technical Report R10-TP-50. 54p.

Holsten, E.H. 1994. The role of spruce beetle pheromones as management strategies In: Management of western bark beetles with pheromones: Recent research and development. USDA For. Serv., Pacific Southwest Forest Research Station, Albany, CA, PSW-GTR-150. Pp 11-15.

Holsten, E.H. 1994. Suitability of powerline right-of-way clearing debris as breeding material for spruce bark beetle. USDA For. Ser., Forest Health Management, Tech. Report R10-TP-49. 6p.

Mask, R.; Hennon, P.E. 1994. Evaluation of bud damage on young-growth Sitka spruce, Long Island, Alaska. USDA Forest Service, State and Private Forestry, Juneau, AK. Forest Health Biological Evaluation R10-TP-44. 15p.

Mask, R.A.; Wolfe, R. 1994. Aerial Survey of Forest Insect and Disease Activity in Alaska. In Proceedings," Aerial Pest Detection and Monitoring Workshop", April 25-29, 1994, Las Vegas, NV. 3 pp.

Reynolds, K.M.; Holsten, E.H. 1994. Classification of spruce beetle hazard, *Dendroctonus rufipennis* (Kirby), in Lutz spruce, Picea lutzii Little, stands on the Kenai Peninsula, AK. Can. J. For. Res. 24:1015-1021.

Reynolds, K.M.; Holsten, E.H. 1994. Estimating priorities of risk factors for spruce beetle outbreaks. Can. J. For. Res. 24:3067-3074.

van Hees, W.S.; Holsten E.H. 1994. Characteristics of a spruce beetle infestation through the use of point-in-time extensive forest inventories, Kenai Peninsula, Alaska. Can. J. For. Res. 24:233-239.

Volk, T.J.; Burdsall, H.H.; Reynolds, K.M. 1994. Checklist and host index of wood-inhabiting fungi of Alaska. Mycotaxon 11(1): 1-46.

Werner, R.A. 1994. Research on the use of semichenicals to manage spruce beetles in Alaska. Pp. 15-22. In: Management of western bark beetles with pheromones: Recent research and development. Proceedings of a symposium, June 22-25, 1992, Kona, HI., USDA Forest Service, Pacific Southwest Forest Research Station, Gen. Tech. Rep. PSW-GTR-150.

Werner, R.A.; Illman, B.L. 1994. Response of Lutz, Sitka, and white spruce to attack by the spruce beetle, *Dendroctonus rufipennis* (Kirby), (Coleoptera: Scolytidae) and blue-stain fungi. Environ. Entomol. 23(2): 472-478.

Werner, R.A. 1994. Forest insect research in boreal forests of Alaska; Trends in Agricultural Sciences--Entomology. Council of Scientific Research Integration. India. 2: 35-46.

ALASKA FOREST HEALTH SPECIALISTS

Anchorage

Forest Health Management
USDA Forest Service
State and Private Forestry
3301 'C' Street, Suite 522
Anchorage, AK 99503-3956
Phone: (907) 271-2575
FAX (907) 271-2897

Jerry Boughton, Program Manager
Edward H. Holsten, Entomologist
Beth Schultz, Ecologist
Kenneth P. Zogas, Biotechnician

Juneau

Forest Health Management
USDA Forest Service
State and Private Forestry
2770 Sherwood Lane, Suite 2A
Juneau, AK 99801
Phone: (907) 586-8883
(907) 586-8769
FAX (907) 586-7848

Paul E. Hennon, Pathologist
Roy A. Mask, Entomologist
Loreen M. Trummer, Coop. Ed. Student

Fairbanks

Institute of Northern Forestry
USDA Forest Service
Pacific Northwest Research Station
308 Tanana Drive
Fairbanks, AK 99701
Phone: (907) 474-3304

Richard A. Werner, Res. Entomologist

Notes:

Notes: